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Foreword

We are honored to be part of the team of professionals preparing the Historic Structure Report (HSR) for the Meramec River U.S. 66 Bridge located near Eureka, in St. Louis County, Missouri. In the ongoing effort to provide comprehensive documentation for this historic bridge structure, the overall objective of the Report was to analyze the Bridge in an effort to preserve its structural and historic integrity and serviceability.

Writing this Report has been no small task. Collecting information, analyzing eighty year-old drawings, coordinating with over twenty Section 106 Consulting Parties and two state agencies in the development of the HSR for one of the most historically significant bridges in the state of Missouri and nationally significant as a U.S. Route 66 bridge as well, all on a tight timeframe has been a seemingly impossible task at times. It was necessary to act quickly as the Missouri Department of Transportation (MoDOT) closed the bridge in October of 2009 with the intent of tearing the bridge down in the summer 2012 if a new owner is not found beforehand. In addition to a new owner, MoDOT must have a “business plan” that sets forth the new owner’s proposed future plan for the Meramec Bridge as well as identifying a potential time line for preservation activities. It is the hope of the Great River Associates Consulting Team that this Report will provide a new owner with as solid a base to build on as the Meramec River U.S. 66 Bridge itself.

The bridge, built in 1931, is 1,008 feet long and because of the age of the construction documents and the complexity of the design, the structural analysis was challenging. To meet the objective of preservation and serviceability as it relates to the original intent of the bridge, it was determined that we should follow the Secretary of the Interior’s Standards for the Treatment of Historic Properties (Standards) [36 CFR Part 68], and their adaptation for historic bridges by the Virginia Transportation Research Council as Guidelines for Bridge Maintenance and Rehabilitation Based on the Secretary of the Interior’s Standards (Guidelines).

The purpose of this document is to develop a plan for the U.S. Route 66 Bridge over the Meramec River. This Historic Structure Report will serve as an essential part of the master plan or as has been referred to in the development of this document, the business plan, the required long-range planning tool for the future use of the bridge and its surrounds, which are integral components of historic U. S. Route 66 in Missouri.

The HSR outlines the historical background and discusses the significance of the bridge. It examines the current condition of the bridge and analyzes the structural capacity for ways to stabilize the bridge, preserve it within its historic environs, and to provide public access to this
important component of U.S. Route 66. The HSR identifies a preferred alternative as well as other alternatives for consideration. The possibility of ownership transfer for the preservation of the bridge is outlined and the legalities of Right of Way (ROW) are presented.

The financial analysis portion of the Report examines the economic feasibility of preservation and rehabilitation costs. The new owner of the bridge will have to expend funds to either stabilize or rehabilitate the bridge; therefore, funding opportunities are presented. The importance of educating the public about the bridge as a historical resource is also recognized. Outreach programs are explored and avenues for gathering public input are identified, recognizing that it will likely be necessary to conduct a capital campaign in an effort to restore the bridge.

It is imperative that the public become educated about the Meramec River U.S. 66 Bridge and its significance to the history of U.S. Route 66, as well as its importance as an intrinsic resource to the State of Missouri’s Route 66 Byway. The Missouri Highways and Transportation Commission Scenic Byway Program is authorized by the Missouri Revised Statutes Chapter 226, Section 226.797 to provide direction for the State Scenic Byways Program for purposes of protecting, preserving and enhancing scenic byways. The benefit in public education about the bridge is multi-faceted. Stimulation of community interest to take action on the preservation of this historic resource will serve as a vehicle with which to garner public opinion and support. Additionally, public interest and cooperation serves as an educational conduit to demonstrate the importance of preservation of community and national historic resources.

An overriding goal for the Report is to promote the responsible utilization of public and/or private funds and to find ways for historic bridge structures and properties to function and continue to benefit the public. We believe that the best way to preserve our historical treasures is to use them. It is through use that appreciation is built. As part of the road itself, the Meramec River U.S. 66 Bridge provides a tangible source of interpretation and historical documentation relating to Route 66. The preservation of the bridge would bring to fruition the ability to enhance, and utilize the bridge for current and future generations.

It is our hope that the Meramec River U.S. 66 Bridge Historic Structure Report will promote a greater understanding of the bridge, and that it will make a lasting and meaningful contribution to the work of its future caretakers.

Spencer Jones, P.E.  
Principal Structural Engineer  
Great River Associates

Jerany L. Jackson, ASLA, MBA  
Department Head of Special Services  
Great River Associates
Project Team

The development of this document, The Meramec River U.S. 66 Bridge Historic Structure Report, was undertaken as a result of the efforts of more than twenty Section 106 Consulting Parties for the Meramec River U.S. 66 Bridge. The Report was funded in part by the National Park Service Route 66 Corridor Preservation Program, in part by Great Rivers Greenway of St. Louis, Missouri and in part by Great River Associates of Springfield, Missouri.

The key to the success of the Meramec River U.S. 66 Bridge Historic Structure Report is the solid foundation of diverse professional team members and contributors. This combination of efforts offers the benefits of a multi-disciplinary professional team with planning and structural engineering experience and the broad-based knowledge of the stakeholders required to develop the Historic Structure Report for the Meramec River U.S. 66 Bridge. Great River Associates, the author of the document, appreciates the time that organizations and individuals took to share ideas, discuss their experiences, and review the pieces of this document. Many of the ideas raised by these stakeholders have been incorporated into this document.

Great River Associates (GRA) is the Project Consulting Firm for the Meramec River U.S. 66 Bridge project. GRA is a multi-disciplinary firm specializing in civil and structural engineering, landscape architecture, land surveying, Geographic Information Systems (GIS), graphic design, and comprehensive planning. GRA project team members were selectively chosen because they possess the experience and knowledge to complete a holistic and comprehensive plan for the Meramec River Bridge.

Great River Associates had the primary responsibility for developing the content and format of the document under the direction of Spencer Jones, P.E. and Jerany Jackson, ASLA, MBA. Great River assembled the teams of contributors and reviewers, and provided direction and untiring support as the project came to fruition. Spencer Jones and Jerany Jackson served as the principal writers and editors.

Mr. Spencer Jones, P.E. is a principal and structural engineer with Great River. Mr. Jones has extensive experience in the area of structural bridge design and engineering and in particular has worked on a number of historic bridge preservation projects. Most notably, he is
currently preparing plans for the rehabilitation of the Missouri Route 66 Devil’s Elbow Bridge in Pulaski County and co-authored the recently completed Missouri Route 66 Corridor Management Plan. Mr. Jones served as the engineer of record on the engineering study and analysis as well as the quality control reviewer, the last stop before the report is complete.

Ms. Jerany Jackson, a Landscape Architect with Great River, served as the project manager for the project. Ms. Jackson has extensive experience in design and planning multi-modal transportation environments. Ms. Jackson has completed numerous historic downtown projects, landscape preservation projects and most recently served as the project manager and co-author of the recently completed Missouri Route 66 Corridor Management Plan. She was responsible for the coordination of the project with the project team, integrating the information generated by the various team members. She also served as author and editor.

Great River gratefully acknowledges the important contribution of their team of experts, who served as core technical advisors for this document. These individuals contributed a substantial amount of technical material and thoughtful comments on drafts and, most importantly, their considerable practical experience in the creation of a technical document. Great River would like to recognize the following staff for their particular contributions: James Ouellette, P.E.; Kathleen Giles, Planner; Ryan Evitts, ASLA, Landscape Architecture Staff and Keith Belt, Graphic Designer.

In addition to GRA, there are a number of team members, key stakeholders in the project, that bring an extensive degree of experience, public administration and funding to this project.

Landmarks Association of St. Louis, Inc. is a non-profit preservation advocate for the region’s cultural resources (est. 1958 / incorporated 1959). Landmarks Association of St. Louis, Inc. is the non-profit agency serving as the fiscal agent until an owner can be found for the bridge. Ruth Keenoy and Ryan Reed (Preservation Specialists) are the primary contacts for Landmarks and have been actively involved in the project since its inception. Keenoy co-wrote the National Register nomination for the bridge and the Route 66 in Missouri Multiple Property Documentation Form (MPDF).
Great Rivers Greenway is the public organization leading the development of the River Ring, a region-wide system of interconnected greenways, parks and trails for the benefit of the St. Louis region residents, visitors and communities. Great Rivers Greenway provided part of the financial match for the Historic Structure Report. The lead agent for Great Rivers Greenway is Lonny Boring, Project Manager.

Scenic Missouri is a 501(c)(3) organization dedicated to the enhancement and preservation of Missouri’s scenic landscapes and communities. It is through Scenic Missouri’s leadership in the Scenic Byways program that the bridge was nominated for inclusion in Missouri Preservation’s 2010 and 2011 Most Endangered List, as well as helping to bring together a large and diverse number of organizations in an effort to save this historic bridge. The lead agent for Scenic Missouri is John Regenbogen, Executive Director.

As part of the required Section 106 Process, agency officials must provide the public with information about a project and its potential effects on historic properties and seek public comment and input. In addition, certain individuals or organizations with “demonstrated interest” in a project may request, or be invited, to participate in project planning activities as consulting parties. Although consulting parties participate in project planning, they may or may not concur with project decisions or conclusions. The following groups and individuals are participating as consulting parties for the Meramec River U.S. 66 Bridge project:

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Glossary of Bridge and Preservation Terms

Appraisal ratings – Five National Bridge Inventory (NBI) inspection ratings (structural evaluation, deck geometry, under-clearances, waterway adequacy, and approach alignment, as defined below), collectively called appraisal ratings, are used to evaluate a bridge’s overall structural condition and load-carrying capacity. The evaluated bridge is compared with a new bridge built to current design standards. Ratings range from a low of zero (0) (closed bridge) to a high of nine (9) (superior). Any appraisal item not applicable to a specific bridge is coded “N”.

Approach alignment – One of five NBI inspection ratings. This rating appraises a bridge’s functionality based on the alignment of its approaches. It incorporates a typical motorist’s speed reduction because of the horizontal or vertical alignment of the approach.

Character-defining features – Prominent or distinctive aspects, qualities, or characteristics of a historic property that contribute significantly to its physical character. Features may include structural or decorative details and materials.

Condition rating – Level of deterioration of bridge components and elements expressed on a numerical scale according to the NBI system. Components include the substructure, superstructure, deck, channel, and culvert. Elements are subsets of components, e.g., piers and abutments are elements of the component substructure. The evaluated bridge is compared with a new bridge built to current design standards. Component ratings range from zero (0) (failure) to nine (9) (new).

Deck geometry – One of five NBI inspection ratings. This rating appraises the functionality of a bridge’s roadway width and vertical clearance, taking into account the type of roadway, number of lanes, and Average Daily Traffic (ADT).

Deficiency – The inadequacy of a bridge in terms of structure, serviceability and/or function. Structural deficiency is determined through periodic inspections and is reflected in the ratings that are assigned to a bridge. Service deficiency is determined by comparing the facilities a bridge provides for vehicular, bicycle, and pedestrian traffic with those that are desired.
Functional deficiency is another term for functionally obsolete (see below). Remedial activities may be needed to address any or all of these deficiencies.

**Deficiency rating** – A nonnumeric code indicating a bridge’s status as structurally deficient (SD) or functionally obsolete (FO). See below for the definitions of SD and FO. The deficiency rating status may be used as a basis for establishing a bridge’s eligibility and priority for replacement or rehabilitation.

**Design exception** – A deviation from standard bridge design practices that takes into account environmental, scenic, aesthetic, historic, and community factors that may have bearing upon a transportation project. A design exception is used for federally funded projects where federal and state standards are not met. Approval requires appropriate justification and documentation that concerns for safety, durability, and economy of maintenance have been met.

**Design load** – The usable live-load capacity that a bridge was designed to carry, expressed in tons according to the allowable stress, load factor, or load resistance factor rating methods. An additional code was recently added to assess design load by a rating factor instead of tons. This code is used to determine if a bridge has sufficient strength to accommodate traffic demands. A bridge that is posted for load restrictions may not be adequate to accommodate present or expected truck traffic.

**Fracture critical** – Classification of a bridge having primary superstructure or substructure components subject to tension stresses which are non-redundant. A failure of one of these components could lead to collapse of a span or the bridge. Tension members of truss bridges are often fracture critical. The associated inspection date is a numerical code that includes frequency of inspection in months, followed by year, and month of last inspection.

**Functionally obsolete (FO)** – The Federal Highway Administration (FHWA) classification of a bridge that cannot meet current or projected traffic needs because of inadequate horizontal or vertical clearance, inadequate load-carrying capacity, and/or insufficient opening to accommodate water flow under the bridge.

**Historic fabric** – The material in a bridge that was part of original construction or a subsequent alteration within the historic period (e.g., more than 50 years old) that has
significance in and of itself. Historic fabric includes both character-defining and minor features. Minor features have less importance and may be replaced more readily.

*Historic bridge* – A bridge that is listed in, or eligible for listing in, the National Register of Historic Places.

*Historic integrity* – The authenticity of a bridge’s historic identity, evidenced by the survival and/or restoration of physical characteristics that existed during the bridge’s historic period. A bridge may have integrity of location, design, setting, materials, workmanship, feeling, and association.

*Inspections* – Periodic field assessments and subsequent consideration of the fitness of a structure and the associated approaches and amenities to continue to function safely.

*Inventory rating* – The load level a bridge can safely carry for an indefinite amount of time expressed in tons or by the rating factor described in design load (see above). Inventory rating values typically correspond to the original design load for a bridge without deterioration.

*Maintenance* – Work of a routine nature to prevent or control the process of deterioration of a bridge.

*National Bridge Inventory (NBI)* – Bridge inventory and appraisal data collected by the FHWA to fulfill the requirements of the National Bridge Inspection Standards (NBIS). Each state maintains an inventory of its bridges subject to NBIS and sends an annual update to the FHWA.

*National Bridge Inspection Standards (NBIS)* – Federal requirements for procedures and frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of state public bridge inventories. NBIS applies to bridges located on public roads.

*National Register of Historic Places (NRHP)*– The official inventory of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture, which is maintained by the Secretary of the Interior under the authority of the National Historic Preservation Act of 1966 (as amended).
**Non-vehicular traffic** – Pedestrians, non-motorized recreational vehicles, and small motorized recreational vehicles moving along a transportation route (includes bicycles).

**Operating rating** – Maximum permissible load level to which a bridge may be subjected based on a specific vehicle type, expressed in tons or by the rating factor described in design load (see above).

**Posted load** – Legal live-load capacity for a bridge usually associated with the operating or inventory ratings as determined by a state transportation agency. A bridge posted for load restrictions may be inadequate for truck traffic.

**Preservation** – Preservation, as used in this report, refers to historic preservation that is consistent with the Secretary of the Interior’s *Standards for the Treatment of Historic Properties*. Historic preservation means saving from destruction or deterioration old and historic buildings, sites, structures, and objects, and providing for their continued use by means of restoration, rehabilitation, or adaptive reuse. It is the act or process of applying measures to sustain the existing form, integrity, and material of a historic building or structure, and its site and setting.

**Preventive maintenance** – The planned strategy of cost-effective treatments that preserve a bridge, slow down future deterioration, and maintain or improve its functional condition without increasing structural capacity.

**Reconstruction** – The act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location. Activities should be consistent with the Secretary of the Interior’s *Standards for the Treatment of Historic Properties*.

**Rehabilitation** – The act or process of returning a historic property to a state of utility through repair or alteration which makes possible an efficient contemporary use, while preserving those portions or features of the property that are significant to its historical, architectural, and cultural values. Historic rehabilitation, as used in this report, refers to implementing activities that are consistent with the Secretary of the Interior’s *Standards for the Treatment of Historic Properties*. As such, rehabilitation retains historic fabric and is different from replacement.
**Restoration** – The act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time. Activities should be consistent with the Secretary of the Interior’s Standards for the Treatment of Historic Properties.

**Scour** – Removal of material from a river’s bed or bank by flowing water, compromising the strength, stability, and serviceability of a bridge.

**Scour critical rating** – A measure of bridge’s vulnerability to scour (see above), ranging from zero (0) (scour critical, failed, and closed to traffic) to nine (9) (foundations are on dry land well above flood water elevations). This code can also be expressed as “U” (unknown), “N” (bridge is not over a waterway).

**Serviceability** – Level of facilities a bridge provides for vehicular, bicycle, and pedestrian traffic, compared with current design standards.

**Stabilization** – The act or process of sustaining a bridge by means of making minor repairs until a more permanent repair or rehabilitation can be completed.

**Structurally deficient (SD)** – Classification indicating NBI condition rating of 4 or less for any of the following: deck condition, superstructure condition, substructure condition, or culvert condition. A structurally deficient bridge requires immediate rehabilitation to remain open to traffic; or requires maintenance, rehabilitation, or replacement.

**Structural evaluation** – Condition of a bridge designed to carry vehicular loads, expressed as a numeric value and based on the condition of the superstructure and substructure, the inventory load rating, and the ADT.

**Substructure** – The substructure includes those parts which transfer the loads from the bridge span down to the supporting ground. For a single-span structure, the substructure consists of two abutments, while for multi-span structures there are also one or more piers (or bents). The loads are applied to the substructure through the bearing plates and transmitted through the abutment walls or pier columns to the footings. If the soil is of adequate strength, the footings will distribute the loads over a sufficiently large area. If not, the footings themselves must be supported on pile foundations extended down to a firm underlying stratum.
**Superstructure** – The superstructure includes all those parts which are supported by the substructure, with the main part being the bridge spans. Vehicular loads are transmitted from the bridge deck, through the supporting girders or truss of the span, and into the substructure. On girder and truss bridges, the slab is supported on longitudinal members which, in turn, carry the load to the abutment or piers. Some superstructures consist of the deck, a floor system, and two or more main supporting members.

** Sufficiency rating** – Rating of a bridge’s structural adequacy and safety for public use, and its serviceability and function, expressed on a numeric scale ranging from a low of zero (0) to a high of one hundred (100). It is a relative measure of a bridge’s deterioration, load capacity deficiency, or functional obsolescence. This rating is used as the basis for establishing eligibility and priority for replacement or rehabilitation. Typically, bridges rated between fifty (50) and eighty (80) are eligible for rehabilitation and those rated fifty (50) and below are eligible for replacement.

**Under-clearances** – One of five NBI inspection ratings. This rating appraises the suitability of the horizontal and vertical clearances of a grade-separation structure, taking into account whether traffic beneath the structure is one- or two-way.

**Variance** – A deviation from standard bridge design practices that takes into account environmental, scenic, aesthetic, historic, and community factors that may have bearing upon a transportation project. A design variance is used for projects using state aid funds. Approval requires appropriate justification and documentation that concerns for safety, durability and economy of maintenance have been met.

**Vehicular traffic** – The passage of automobiles and trucks along a transportation route.

**Waterway adequacy** – One of five NBI inspection ratings. This rating appraises a bridge’s waterway opening and passage of flow through the bridge, frequency of roadway overtopping, and typical duration of an overtopping event.
Report Summary

Project Background
Project Data
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Project Background

Located approximately two miles east of the City of Eureka in St. Louis County, Missouri, along the Historic U.S. Route 66 alignment, the Meramec River U.S. Route 66 Bridge is an example of a Warren deck truss. The Warren deck truss is a rare structural design in Missouri; only four examples remain standing and this bridge is the state's solitary three-span rigid deck truss structure.

Constructed in 1931-1932, the Meramec River U.S. Route 66 Bridge historically transported traffic across the Meramec River at a regionally significant river crossing associated with the original alignment of U.S. Route 66. The bridge connects two pieces of the Missouri Route 66 State Park and provides a critical link to the park's 250,000 annual visitors between the Route 66 Visitor Center (on the east side) and the 419-acre park (on the west side). The west side of the river was the entrance of the former Times Beach community. The park and visitor center are operated by the Missouri Department of Natural Resources (MoDNR).

Because the bridge was constructed to carry traffic on U.S. Route 66, a national historically significant highway, the connection is an important tie to not only Missouri's past, but also the nation's transportation history. The bridge is a critical part of the overall Route 66 experience for tourists and international travelers, as it connects to the only state park dedicated to Route 66 on the Route in the nation.

The bridge also serves as a significant bicycle and pedestrian link for the Meramec Greenway and the City of Eureka trail systems. This link provides a critical connection to thousands of acres of public open space acquired with millions of dollars, some from public funding and some from private fund raising.
The Missouri Department of Transportation (MoDOT) owns the bridge, which, when it was open, carried about 2,640 cars a day between the Center and the Park. The Historic U.S. Route 66 Meramec River Bridge, listed on the National Register of Historic Places in 2009, has not experienced any major alterations over the years. However, time has taken its toll on the bridge, and MoDOT made the decision to close it to all traffic in 2009. MoDOT decided it could not invest the money needed to maintain the bridge, since many other major bridges around the region, with higher traffic volumes, continue to need maintenance. MoDOT maintains that if the bridge is not removed in the next several years, it could collapse under its own weight. The bridge is scheduled for demolition in summer of 2012 unless a new owner can be found, and support and monies are raised to show evidence of the public’s need and interest in the bridge.

During the planning stages for projects involving federal action, a systematic process is undertaken to identify cultural resources within the project area, analyze the project’s potential to impact them, and determine what action will be taken to eliminate or mitigate any identified impacts. This process is commonly referred to as “Section 106,” after the portion of the National Historic Preservation Act (1966), which requires agencies to take into account the effects of their actions on historic properties.

Because this bridge is on the National Historic Register, MoDOT is mandated by law to go through the historic preservation process, referred to as the Section 106, to determine if another group or agency will be willing to accept the ownership, liability and costs for maintaining the Meramec River U.S. Route 66 Bridge. Figure 1 above shows the schedule MoDOT presented in July 2010 and has been following for the Section 106
process. Nearly twenty individuals or organizations indicated in writing that they have a demonstrated interest in the Section 106 undertaking, or concern regarding the undertaking’s impact on the historic bridge. As defined in The Regulations of the Advisory Council On Historic Preservation 36CFR Part 800, the term “consulting party” identifies a person or organization that may become involved in the planning process of a federal undertaking. A federal undertaking can be a project that contains any type of federal involvement including assistance, permit or license.

According to MoDOT’s website, “In addressing historic bridges in Missouri, the term “bridges” collectively refers to both public and privately owned highway, railroad, and pedestrian bridges, viaducts, and culverts. Historic bridges are listed in or eligible for listing in the National Register of Historic Places (NRHP). Because they are in the public right of way, MoDOT is responsible for identifying and managing historic bridges associated with highway projects.

In 1996, Missouri historic bridges were inventoried and evaluated statewide. The Surface Transportation and Uniform Relocation Assistance Act of 1987 (STURAA) directed all states to inventory their historic bridges. There are about 24,000 bridges in the State of Missouri (this includes state, county, and city-owned bridges). The 1996 Missouri Historic Bridge Inventory survey evaluated approximately 11,000 constructed prior to 1951. Of these, 399 were identified as listed in, or potentially eligible for listing in the NRHP.

The results of the inventory, with some modifications, became what is known as the Missouri Historic Bridge List (MHB List). It contains about 25 types of structures including a variety of metal pony trusses and through trusses, wooden trusses, concrete arches and rigid frames, stone arches, etc. All were built between 1858 to 1954.

Bridges not on the MHB List are evaluated for NRHP eligibility in consultation with the State Historic Preservation Office (SHPO). Through the Section 106 process, a project can have “no effect”, “no adverse effect” or an “adverse effect” on a historic bridge.

An adverse effect occurs when a project would harm a historic bridge’s ability to convey its historic significance. Examples of adverse effects include demolition, removal from the original location, removal or alteration of original bridge parts, and introduction of new elements that diminish the bridge’s significant historic features.

If a project is determined to have an adverse effect on an historic bridge, efforts must be made to minimize the effects through redesign of the project. If an adverse effect cannot be avoided, a Memorandum of Agreement is negotiated outlining measures to mitigate the effects of the project on the resource.

Mitigation typically includes archival photographs, and preparation of a thorough history and detailed written description, which are then archived at the state or national level depending upon the range of significance. Mitigation also may include marketing and advertisement for adaptive
reuse at the existing location or at a new location, dismantling and storing the bridge for future use on another site, salvaging important historical components of the bridge for reuse as educational or interpretive materials, or reusing salvaged components on similar historic bridges in need of rehabilitation.

Missouri Department of Natural Resources (MoDNR) State Parks Division owns and operates the Route 66 State Park and Visitors Center which is located on either end of the bridge. While MoDNR has indicated their support for the preservation of the bridge, the agency is reluctant to assume ownership citing a lack of expertise in bridges and decline in funds to care for state parks. MoDNR has participated in all of the Section 106 Consulting Party meetings and has written letters of support for the two successful grants received for bridge preservation efforts.

MoDOT and MoDNR, and the Section 106 Consulting Parties, as well as members of the public recognize the significant historical contribution that the Meramec River U.S. Route 66 Bridge makes to the State and Nation with regard to Route 66 history. The significance to the region in terms of the important connection over the river to the thousands of acres of public open space, and the regional multi-modal transportation network that serves locals as well as tourists is also apparent.

It is also recognized that the Warren deck truss bridge is a rare structural design in Missouri. Out of the ten constructed in the state, only four examples remain standing. The Meramec River U.S. Route 66 Bridge is the state’s solitary three-span rigid deck truss structure and the only Warren deck truss bridge left in the state that has not been rebuilt.

Many things are known about this bridge, what is not known is who will take temporary or permanent ownership to save this treasure or whether it will become a part of the past.
Project Data

Location Data

Bridge Name: Meramec River U.S. 66 Bridge

Bridge Location: Historic U.S. Route 66 (1932 alignment) spanning the Meramec River

MoDOT Bridge: # J-0421

Related Studies

Cassity, Michael. “Route 66 Corridor National Historic Context Study”.


Cultural Resource Data

National Register of Historic Places: The Meramec River U.S. 66 Bridge was listed in the National Register of Historic Places on September 16, 2009.

Period of Significance: The Period of Significance for the Meramec River U.S. 66 Bridge begins in 1931 - 1956, when construction was completed. The Period of Significance relates to the bridge’s era of construction and use as the sole Route 66 Meramec River crossing from 1931 to 1956. With regard to the National Register of Historic Places, the level of significance for the bridge is statewide in relation to its design, which is uncommon in Missouri and as an intrinsic resource to the state Byway. However, the bridge is significant to Route 66 as an intrinsic resource nation-wide in the greater context of Route 66 as it travels across the country and internationally with regard to its importance as an intrinsic resource to historical Route 66.
Part 1
Developmental History

- Historical Background and Context
- Evaluation of Significance
- Physical Description
- Description of Current Conditions
- Structural Evaluation
Historical Background and Context

The historical background of the Meramec River U.S. 66 Bridge has been well documented in the National Register of Historic Places nomination form. A copy of the nomination form is included as an appendix to this report. This section does not repeat the entire history, but includes a summary of that work. Footnoting will not be provided for the following information.

The history of the Meramec River U.S. 66 Bridge is strongly associated with the development of modern highways and bridges in the United States. The state’s bridge building history roughly parallels what occurred nationally. Historically, bridge builders adapted techniques used by earlier builders. Throughout the United States and Europe, modern bridge building was heavily influenced by 19th century railroad companies. Materials and design were crucial in developing early railroad bridges. In the United States, the most common building material for railroad bridges was wood. It was less expensive and more available than stone. Most American railroads continued to use wood even when iron became available. This was true in Missouri as well. Missouri did not begin using iron and steel until the late 19th century. This delay came in part from the fact that the Civil War began at about the same time as the state began to build railroads. The War caused many projects to be delayed and some were abandoned. Additionally, the state’s two primary rivers – the Mississippi and the Missouri – required technological advances for bridges that did not occur until the mid-to-late 19th century.

The world’s first railroad bridge – Causey Arch Bridge in County Durham, England – was constructed of stone in 1720 to support horse-drawn coal wagons. Later it supported steam locomotives and was the example that most subsequent bridge builders followed. In the 1820s, Stephenson, Brunel and Locke designed railroad bridges. The best known of these is the Royal Border Bridge – a stone viaduct across the River Tweed that
separates Scotland and England. That bridge (still standing) was completed in 1849. It is a semi-circular arched masonry and wood structure spanning approximately 2,162 feet. Railroad builders continued to use brick and stone for railroad bridges in Europe until the mid-19th century when cast-iron became available. Timber remained the primary choice for most American bridge builders until the late 19th century due to its abundance and affordability.

Cast-iron provided tension strength unmatched by timber – a critical factor in railroad bridges with long spans. The tension strength of wrought-iron was even greater than cast-iron. However, because wrought-iron was nearly twice as expensive as cast-iron, it was usually used in conjunction with other materials such as cast-iron and wood. Iron bridges began to appear in America after 1830 – although they had been successfully introduced by the 1780s. The world’s first iron bridge was constructed in 1778 by Thomas Farnolls Pritchard across the River Severn in Shropshire County, England. The bridge remains standing today. The first iron bridge in the United States, Dunlap’s Creek Bridge, was constructed in 1838 on the National Road in Brownsville, Pennsylvania. The designer, Richard Delafield, used iron because it was permanent (not wood) and was the most efficient in terms of cost and durability. The bridge still stands today.

Iron bridges relied on the use of pins and trusses, which made the bridges easier to assemble, were lighter than stone and wood, and were able to support heavier loads. In America, the most popular form of iron bridge was the truss bridge. Truss bridges are supported by triangular placement of beams which make the roadbed stiff and strong. Suspension bridges provide support from above the roadbed and arched bridges provide support from below the roadbed. Truss bridges, on the other hand, rely on a long, straight, horizontal chord at the top and bottom of the bridge. The chords are connected by a web of vertical posts and diagonals, serving to create the central part of the trusses. Support is also provided by abutments at either end of the bridge, and in some cases by central piers. Iron served extremely well in constructing truss bridges and thousands were constructed across the country during the mid-to-late 19th century. Less than 100 iron bridges remain standing in the United States today.

Advances in bridge designs during the 19th century most often focused on truss patterns. Truss patterns evolved rapidly after metal bridges came into fashion. Many designs were innovative and durable and worked well for railroad and automobile bridges.
Every builder tried to devise ‘the’ truss that would be economical, simple to construct and viable for longer lengths. The Civil War and the advent of railroads in Missouri had a far-reaching effect on the development of roads and bridges. Railroads became the leading factors in long distance travel, motivating bridge construction in Missouri. Railroads finally triggered the construction of bridges over the Mississippi and Missouri rivers – rivers that had previously limited travel in the state.

Missouri’s landscape is largely dominated by its rivers. The nation’s second largest river, the Mississippi, runs along the eastern edge of the state and extends some 2,300 miles in length from its headwaters in Minnesota to the Gulf of Mexico. The Mississippi is widest at its confluence with the Missouri River just north of St. Louis, Missouri. The size and flooding associated with the river system prevented bridge construction until well into the late 19th century. Few bridges constructed prior to 1850 still exist.

The first Mississippi River railroad bridge was completed in 1854, linking Rock Island, Illinois and Davenport, Iowa. A number of other projects were constructed on the Mississippi – completed after the Civil War. One of Missouri’s earliest railroad bridges on the Mississippi was constructed in 1868-71 at Hannibal. A number of other bridges were constructed across the Mississippi by 1874. The nation’s first “all-steel bridge” was constructed in 1879 in Glasgow, Missouri, across the Missouri River. Steel had several important advantages over iron. Steel could be shaped in any way without reducing its strength and it was much lighter than iron, which made it adaptable to nearly every design. By the beginning of the twentieth century, steel had become the material of choice for bridge construction.

The advent of the automobile in Missouri (and the nation) began the change from railroad construction to the construction of roads and bridges aimed to serve the automobile. Until the advent of the
automobile, few improvements were made to the state’s roads and bridges, except for those serving the railroad. This was due largely to the shortage of funds for these improvements. Local governments were primarily responsible for the construction and maintenance of roads and bridges. This began to change with the nation’s Good Roads Movement, sparked by automobile and bicycle enthusiasts during the late 19th century. Missouri’s Good Road advocates were instrumental in gaining political support for laws that improved the state’s funding for road and highway bridge construction.

Automobiles were introduced to Missouri around the turn of the century. St. Louis was one of the nation’s few cities that had a network of paved roads, which made the state an early center of automobile development. Missouri’s roads were improved after 1900, but by 1920 less than ten percent were paved. Changes in the states legislation during the early 1900s slowly switched the funding responsibility for building roads solely from the local communities to the state.

The Federal government also began planning a transportation network that would link states via existing and new roads. The Federal Highways Act of 1916 was the first legislation to provide federal assistance for interstate roads. Missouri’s Hawes Act of 1917 assisted the federal funding. Missouri was therefore able to modernize existing roads, survey new routes and standardize highways. This included permanent road and bridge work and the implementation of new bridge design.

Through the state and federal funds received for roads during the 1920s, Missouri was able to create a network of state roads and support one of the most important national highways, U.S. Route 66. Designated as a federal highway in 1926, Route 66 in Missouri was possible in large part because of the state’s modern bridges that linked the road across the state.

The Meramec River U.S. 66 Bridge – J-0421 was constructed in 1931-32 to serve the needs of Route 66. The structure spans a large body of water that although secondary in size to the Mississippi and Missouri Rivers, was no less problematic for bridge builders. Earlier bridges had been constructed across the Meramec near Eureka prior to 1931; but the Meramec River Bridge was the first specifically designed for automobiles.
U.S. Route 66 was heavily promoted as a tourist attraction. However, the lower Meramec River was already a well-known resort area with established hotels and commercial activities attracting visitors from the St. Louis area and beyond – originally by train and later by automobile. The area, specifically the community of Times Beach, grew into a permanent community when the improvements of roads and cars made commuting more practical combined with a shortage of housing in St. Louis. Route 66 and the Meramec River Bridge enhanced the growth of the area.

The Meramec River U.S. 66 Bridge was constructed by the Frazier-Davis Construction Company which was established in 1917 by Adrian W. Frazier and Edward C. Davis. The firm specialized in heavy industrial construction work, with projects in many parts of the United States. The Illinois Steel Company of Chicago produced the steel components used in assembling the bridge.

The bridge incorporates a rigid-connected Warren truss deck design. Deck trusses like that used in the Meramec River Bridge were infrequently used in Missouri because the state’s waterways are flat and often do not provide sufficient clearance for water traffic below the deck trusses. In Missouri, most deck truss bridges were constructed during the 1920s and early 1930’s. All were designed by the state highway department and only where under-truss clearance was not an issue. Out of the ten originally constructed, only four rigid connected Warren deck truss bridges still exist in Missouri and the Meramec is the only one that has not been reconstructed. The Meramec River Bridge is the only three-span deck truss in the state.

In 1956, the state initiated construction on Interstate-44 (I-44), which currently passes south of the 1931 Meramec River Bridge. Route 66 reached its zenith during the early 1950s. By this time, state and federal agencies had identified the road as extremely dangerous due to its narrow width, lack of federal safety standards and rapid deterioration due to constant and heavy traffic. By the late 1960s, I-44 was nearly complete in Missouri, and the state began to decommission sections of Route 66 as the interstate opened. In 1956 new lanes were constructed to carry eastbound traffic. The bridge continued to carry west bound traffic until 1970 when new westbound lanes for I-44 were completed. Nationally, Route 66 was officially decommissioned in 1985; local sections were often decommissioned.
incrementally as sections of I-44 opened. The bridge remained open and in use for local traffic serving the community of Times Beach, accessible via an interchange linking Route 66 with I-44. According to Karen L. Daniels in the document she prepared for MoDOT, “Historic Documentation, Bridge J-0421, Meramec River Bridge”, May 2011, it served that purpose until 1983 when the community was declared a hazardous waste site and quarantined for cleanup.” Today, the bridge is closed to all traffic, but remains within the boundaries of Route 66 State Park, which opened in 1999. The park on the west side of the river is located on land which was previously occupied by the community of Times Beach, a town destroyed by an environmental hazard, which was purchased by the state, completely removed and cleaned of hazardous waste.

The Meramec River separates the state park visitor center, located on the east side of the bridge, from the bulk of the park, which borders the western side of the bridge. The 419 acre-park interprets and showcases the surrounding environment and portions of Route 66 within its boundaries, including the bridge one of only three Route 66 artifacts left in the park. The state park is the only state park on the entire national road named for Route 66. Attendance at the Route 66 State Park is approximately 250,000 visitors annually. The Meramec River Bridge is an exemplary component of Route 66 and one of the state’s best examples of its unique deck truss design.

On October 29, 2009, the Meramec River U.S. 66 Bridge was closed to all traffic by MoDOT due to safety considerations that the agency had. MoDOT made the decision that the department could not invest the money needed to maintain the bridge, as many other major bridges around the region, with higher traffic volumes, continue to need routine maintenance and repairs, and that this route did not provide system connectivity with the highway network.
Evaluation of Significance

The Meramec River U.S. Route 66 Bridge was listed on the National Register of Historic Places in 2009. The bridge serves as a key feature in the history of Route 66 nationally, although its significance relating to the National Register nomination is identified as being of statewide significance. The bridge was nominated under the Multiple Property Documentation Form (MPDF) entitled “Route 66 in Missouri.” Ruth Keenoy, a Landmarks of St. Louis staff member and key project team member, co-wrote the National Register nomination for the bridge and the Route 66 MPDF (Missouri) along with Terri Foley, a historic preservation consultant.

The Missouri State Historic Preservation Office has been involved in identifying the bridge as a significant historical property for years. Mark Miles, Director, supervised the identification and nomination of the bridge to the National Register of Historic Places, and the resource was identified in a 1996 statewide bridge inventory as eligible for the National Register. The bridge’s significance relates to its design and construction (Criterion C of the National Register of Historic Places). It is a rare property type in Missouri with only ten rigid-constructed Warren deck truss bridges constructed statewide. Only four extant examples are still standing, including the Meramec River U.S. Route 66 Bridge. Additionally, the bridge’s significance relates to Route 66 (Criterion A of the National Register of Historic Places). It was the first automobile bridge to span the Meramec River in Missouri and it was designed specifically for the highway which served as a federal transportation route prior to the interstate system.

U.S. Route 66 in Missouri passed through portions of St. Louis, Franklin, Crawford, Phelps, Pulaski, Laclede, Webster, Greene, Lawrence, and Jasper Counties (northeast to southwest), roughly following the Old Wire Road and the St. Louis-San Francisco
Railroad. The Old Wire Road was designated as a “preliminary” national highway as early as 1916 in relation to the Federal-Aid Road Act in which Congress appropriated $75 million per year for federal road construction/improvements. By 1921, U.S. Route 66 was paved in St. Louis and Franklin Counties. Further west, U.S. Route 66 from Springfield to Joplin was paved early on with concrete (by 1922) and considered one of the best sections of the road. In early 1928, Rolla and Springfield newspapers indicated that plans were underway to pave all of U.S. Route 66 (in Missouri) with concrete by 1930. Culmination of the completion of U.S. Route 66 in Missouri is closely tied to the construction of the bridge spanning the Meramec River. The road’s final paved section was completed in 1931 – 72 miles between Rolla and Springfield. The Meramec River U.S. Route 66 Bridge was under construction in that year and was completed in 1932.
Physical Description

The Meramec River Bridge is a steel rigid-connected Warren deck truss bridge resting on reinforced concrete abutments and reinforced concrete piers/bents. The bridge is 1008 feet in length and consists of three 130-foot truss spans. The Warren truss design features vertical web members that create equilateral triangles. The bridge’s diagonal truss members create a series of alternating “V” and “A” shapes that extend the length of the truss. The bridge is reinforced with concrete abutments, wingwalls, and piers with bullnosed cutwaters. Automobiles travel along the roadbed extending above the deck truss that is additionally supported by the bridge’s horizontal chords.

Superstructure

The Meramec River Bridge superstructure is comprised of the components that span the Meramec River. This segment of the bridge carries the traffic load and distributes the load to the substructure. The superstructure of the Meramec River Bridge includes the following components:

**Bridge deck** – the roadway section of the Meramec River Bridge is 30 feet wide including shoulders. The bridge deck is constructed of reinforced concrete (concrete with steel bars for increased tensile strength). The bridge deck conforms to the grade of the approach roadway, so there was no bump or dip as traffic passed on and off of the bridge. Its total length is 1008 feet.
**Structural members** – for the approach spans, the bridge deck is supported by steel plate girders (beams aligned with the length of the spans that support the deck). For the main spans, the bridge is supported by steel deck trusses. A truss is a frame of members that creates tension (pulling force which tends to lengthen a member) and compression (pushing force which tends to shorten a member) that support the bridge load. Used in the same way as a beam, consisting of several smaller members that can be constructed longer and/or deeper than beams or girders.

**Railing** – these are the steel bridge angle pipe guardrails and pipe handrails. Total footage of handrails and railings for the Meramec River Bridge was 4,052 feet.

**Substructure**

The substructure of the Meramec River Bridge includes the abutments, piers, and footings that support the superstructure. The bridge’s substructure has concrete bents (a traverse frame designed to support either vertical or horizontal loads) on piling and concrete piers.

**Abutments** – the element of the bridge supports the extreme ends of the Meramec River Bridge and restricts the approach embankment, thus permitting the embankment to be built up to grade with the bridge deck. The Meramec River Bridge features concrete abutments.

**Piers** – the Meramec River Bridge is supported by concrete piers. The piers are located between abutments to support the ends of the multi-span superstructure.

**Bents** – the concrete bents of the Meramec River Bridge comprise a frame made of reinforced concrete that supports the vertical load and is placed transverse to the length of the bridge structure. The bents are used to carry the load of the beams and girders.
Piling or Pile – the bridge has concrete pilings, a long column driven deep into the ground to form a component of the foundation or substructure. The bent is located at the top of the piling.

Footing – the Meramec River Bridge has concrete footings that rest directly on the soil and bedrock; usually footings are located below grade and are not visible.

Wingwalls – the concrete wingwalls of the Meramec River Bridge were designed to be an extension of the abutment and are used to contain the fill of the approach embankment.

The Meramec River U.S. 66 Bridge is well preserved and has not experienced any alterations, although it has fallen into disrepair. The bridge is a rare and intact example of the rigid-connected Warren Deck Truss and one of the four that remain in Missouri. All of the structural elements and features specific to this design exist in the Meramec River Bridge and are unchanged. The bridge retains its distinctive truss configuration and all of its vital components of design, workmanship and materials. It appears substantially as it did when it was completed in 1932, when it served as an important Meramec River crossing for U.S. Route 66.
Description of Current Conditions

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<thead>
<tr>
<th>General Structure Information</th>
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<tbody>
<tr>
<td><strong>Owner:</strong> MoDOT</td>
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<tr>
<td><strong>Bridge Name:</strong> Meramec River U.S. 66 Bridge</td>
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<tr>
<td><strong>Bridge Location:</strong> Route 66 State Park, Eureka, Missouri</td>
</tr>
<tr>
<td><strong>Bridge #:</strong> J-0421</td>
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<td><strong>Construction Date:</strong> 1931</td>
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<td><strong>On the NBIS:</strong> Yes</td>
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<td><strong>Feature Crossed:</strong> Meramec River</td>
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<tr>
<td><strong>Facility Carried:</strong> Outer Road of Route 44 E</td>
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<tr>
<td><strong>Length:</strong> 1,008 feet</td>
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<td><strong>Number of Spans:</strong> 12</td>
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<td><strong>Main Structure Type:</strong> Truss-Deck</td>
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<tr>
<td><strong>Maximum Span Length:</strong> 131 feet</td>
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<tr>
<td><strong>Deck Width:</strong> Curb-Curb: 29 feet, 10 inches, Out-Out: 31 feet, 5 inches</td>
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<td><strong>Structure Status:</strong> Closed</td>
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<td><strong>Scour Assessment:</strong> 3</td>
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<td><strong>Condition Rating Information:</strong></td>
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<td><strong>Superstructure:</strong> 3</td>
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<tr>
<td><strong>Substructure:</strong> 3</td>
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<tr>
<td><strong>Channel:</strong> 5</td>
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<tr>
<td><strong>Date of last Inspection:</strong> July 2009</td>
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</table>

- Definitions for some of the terminology can be found in the Glossary.
Modifications and Dates

No significant modifications have been made to the Meramec River U.S. 66 Bridge since construction was completed in 1931. Repairs have been made to the substructure, and some modifications to the floor beams due to deterioration.

Current Conditions

Available information was reviewed prior to assessing the options for preservation of the Meramec River U.S. 66 Bridge and visiting the bridge site. Available information, cited in the Project Introduction section of this Report was reviewed to develop a baseline for analysis. Additionally, a site visit was conducted to observe the following:

1. General condition of structural members
2. Conformity of structure to available plans
3. Roadway geometry and alignment
4. Bridge geometry

Review of Inspection Data

The bridge consists of 12 spans with the eastern approach being a two girder system. The main superstructure is a three span continuous deck truss, with the west approach being a series of eight, two girder system. With the two girder system and the truss system, the bridge is considered a fracture critical structure. The bridge has received numerous inspections by its current owner, the Missouri Department of...
Transportation (MoDOT), and during these inspections, the condition of the bridge was determined to be deteriorated to a point that the bridge was closed in the fall of 2009.

After the collapse of the I-35 Bridge in Minneapolis in August of 2007, specific attention was given to the inspection of gusset plates for truss bridges. The Meramec River Bridge received a Comprehensive and Fracture Critical Bridge Inspection by MoDOT from July 29 to August 12, 2009. This inspection was an all inclusive inspection that included a general inspection, a fracture critical inspection and an in-depth inspection, and a gusset plate inventory inspection. The inspection procedures involved performing ground level and roadway level visual observations, soundings of the substructure and the utilization of a snooper truck to access the areas not accessible from the ground. The soundings of the substructure units were to record the extent of delimitation and potential repairs. A log sheet was kept to quantify these repairs. The fracture critical members were inspected at “arms length” for the total surface of each member. Cracks or section loss were noted as observed. Additionally, the gusset plates were measured to verify thickness and document section loss. At these locations, a minimum of four measurements were taken with an ultrasonic type device. When section loss was encountered, additional readings were required to be taken to adequately document the amount of section loss. Likewise, section losses in fracture critical members were also verified by ultrasonic means. Portions of this inspection are summarized below.

**General Inspection Findings** (from MoDOT’s inspection log):

**Superstructure:**

**Deck** - Heavy spalling at the underside of the deck joints is common at most bents and piers along the floor beams. There is extensive exposure of the reinforcing steel at these locations. The deck is delaminated and general water saturation is evident throughout.

**Span 1 (Plate girder system)** - No deficiencies were noted on the two girder system. The first four or five floor beams are twisted on the outside. Three or four floor beams were found to have cracks in the top of the floor beams, where the knee braces are located above the girder.
Span 2, 3, and 4 (Deck Truss):

The main observation in the truss members is the section loss that was primarily located at the ends of the truss. The section loss averages between 35% and 45% at these locations. It was also noted that the gusset plates at the lower chord interface showed some section loss as well. The vertical end posts have holes either at the top or bottom of the post. Heavy rusting and section loss was observed at the lateral bracing at the deck truss ends. Other random areas with much less section loss occurs in other areas of the lower chord.

Spans 5 thru 12 (Plate girder system)

The western span’s conditions were similar to the eastern approach. No deficiencies were noted on the two girder system. The issue, again, was the condition of the floor beams.

Bearings:

The bearings for the truss and some of the plate girder bearings are in need of maintenance and repairs.

Substructure:

The east abutment and the main river piers were found to be in sound condition, with random cracks. The Pier 2 footing is exposed at the ground line and would need protection measures against scour. The western intermediate bents and abutment have the greatest amount of deterioration. Many of these have had repair work in the past. Column deterioration is now the predominate deterioration. Some of these locations have exposed reinforcing steel which show signs of corrosion.

Bank and Channel:

An underwater inspection of the footings was conducted in July 2006. No significant findings were noted. Due to the Pier 2 footing being on rock and exposed, the pier requires field review after extreme flood conditions to ensure that undermining has not occurred. No undermining has been reported to date at the Pier. As additional information regarding bridge scour, the U.S. Geological Survey conducted a Level II
Bridge Scour Analysis for the Meramec River U.S. 66 Bridge in 2002. From this analysis, it was computed that the 100-year storm event would cause moderate exposure of the bent and footing piers.

**Expansion Devices:**

The expansion devices and open joints in the deck are in poor condition and are in need of repair and/or replacement.

**Paint Condition:**

The paint is chalking and fading throughout, and there is widespread peeling of the topcoat. There are also areas of paint failure down to bare steel. While some areas are experiencing heavy rusting, the average degree of rust places it in “fair” condition.

**Bridge Railing:**

The bridge railing consists of a double steel pipe system. The pipe rail is disengaged at span 3 on the left side.

**Conclusion**

Over the years, constant use and inconsistent maintenance have left the Meramec River U.S. 66 Bridge in need of repair. In general, the main deficiencies noted are primarily the result of water damage, corrosion of steel members. Also of general note, the lack of protective coating, paint, is both a real and a perceived deficiency, more so than the other elements, primarily as the result of lack of maintenance.

The purpose and goal of this Historic Structure Report is the preservation and maintenance of the Meramec River U.S. 66 Bridge. The best solution to address routine maintenance issues, and the more critical deficiencies is by following the guidelines developed by the Secretary of the Interior Standards included in Appendix A. And, the main issues identified here have been appropriately addressed through preservation recommendations made by the Great River Association Consultant Team in the Alternatives Section of this document. The outline below provides an overview of the step taken to get to this point, and the order by which the remaining task will be accomplished.
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<thead>
<tr>
<th>STEP</th>
<th>ACTION</th>
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<tbody>
<tr>
<td>1</td>
<td>Develop statement of historic significance</td>
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<tr>
<td>2</td>
<td>The Bridge Team will review available construction plans and review records</td>
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<tr>
<td>3</td>
<td>Perform structural analysis for intended use</td>
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<tr>
<td>4</td>
<td>Perform a site visit to confirm or establish the following:</td>
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<tr>
<td></td>
<td>• Confirm condition of structural members</td>
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<td></td>
<td>• Take photographs as needed</td>
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<td></td>
<td>• Assess safety, geometry and clearances</td>
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<tr>
<td>5</td>
<td>Preliminary cost estimates for preservation options</td>
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<tr>
<td>6</td>
<td>Prepare a report on findings</td>
</tr>
<tr>
<td></td>
<td>• Statement of historic significance</td>
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<td>• Preservation options</td>
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<td>• Cost estimates</td>
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<td>• Funding options</td>
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Structural Evaluation

In an effort to determine the structural performance of the Meramec River U.S. Route 66 Bridge, the decision was made to analyze the structure in accordance with today’s design standards. This approach would take advantage of the present methodology in bridge design, and therefore, could be used to assess its capacity in regards to current and anticipated future loading conditions. This is the customary standard of practice to which new bridges are designed. The computational data presented in this report was prepared by analyzing the Meramec River U.S. Route 66 Bridge superstructure against the modern American Association State Highway Transportation Officials (AASHTO) Load Resistance Factor Design (LRFD) Bridge Design Specifications. This design reviewed a vehicle loading of HL-93. HL-93 loading is a notional representation of shear and moment produced by a group of above-legal limit vehicles routinely permitted on the highways in various states. It is called notional because it is not intended to represent any particular truck, but produces the same extreme load effects as the above-legal limit vehicles.

Furthermore, the LRFD design approach uses this notional traffic loading in combination with other load effects each of which are factored (either up or down) according to likelihood of simultaneous occurrence and their relative variability. This produces various loading combinations which recognize that the maximum effects of all transient loads considered will not be observed at any given moment, while maintaining a uniform reliability.

Similarly, the theoretical ability of members to resist the design load effects is factored (always reduced) to account for unavoidable variations in materials, design equations, fabrication, and erection. The degree of the reduction factor is dependent upon variability in testing data.

The load and resistance factors have been calibrated by trial designs to provide a high, uniform level of safety in new bridges, expressed by a reliability index. LRFD
provides a reliability index of about 3.5 for different types and for different configurations of bridges. This ensures that only 2 out of 10,000 design elements or components will have the sum of the factored loads greater than the factored resistance during the design life of the structure. Using this standard to evaluate historic bridges can be challenging.

One of the challenges was interpreting the available construction documents. Digital scans rendered from microfiche images of the original hand drafted contract plans proved to be difficult to read in some instances, particularly with regard to reading fractional dimensions. Scans of the shop drawings provided a second source of information, but presented similar interpretation difficulties. In order to obtain the most accurate information possible, three experienced professionals performed independent reviews of both sets of documents to extract the information for use in the analysis.

A notable example would be the Section 6.10 provisions (I-Section Flexural Members). This section of the modern code assumes that plate girders will consist of a top and bottom plate continuously welded to a web plate. The plate girders for the Meramec River U.S. Route 66 Bridge however, consist of multiple top and bottom plates attached to angles which are in turn attached to the web plate. All attachments use rivets in various patterns in lieu of the continuous welding. The plate girders and the truss members where constructed from multiple steel shapes. Due to this multiple component configuration, custom spreadsheets were developed to allow the data to be computed into a format that could be utilized by current modeling software. To assist with the computations, a three dimensional analysis program called RISA 3D was used.

A second challenge commonly encountered with the analysis of historic bridges is in the application of the AASHTO Specifications to the bridge. The construction techniques, materials, and configurations used on the Meramec River Bridge vary significantly from today’s modern bridges. As a result, in some instances, the LRFD specifications contain provisions which are not directly applicable to the existing bridge. In order to complete the analysis, it was necessary to adapt the application of those provisions using professional judgment and experience.

Methodology:

The following approach was used for both the plate girder and truss member analysis.

The first step was to determine the principal structural properties of each built up and
historic member section i.e. strong and weak axis moments of inertia, section modulus, compressive areas etc. This was achieved by a combination of researching historical member property tables and analysis spreadsheets customized for the purpose.

Once the properties were known, a three dimensional model of the various bridge spans was constructed utilizing the RISA 3D program. Within the RISA 3D program, general members were defined by assigning their computed properties. The bridge elements were then assigned dead and live loading in accordance with the AASHTO Specifications. Factored load combinations were developed to determine the response of the bridge span members to the various possible combinations of design lane and design truck/tandem moving loads and pedestrian loads for the Strength I limit state. Other limit states such as Strength III incorporating wind loading, Service I for comparison with deflection criteria, and Fatigue may also be appropriate, but are not covered in the scope of this report.

The applicable maximum resultant forces for each member under each load combination, was computed. The maximum load effects were then input into a custom spreadsheet. The spreadsheet applies applicable effect modifiers for the number of design lanes considered as well as the Average Daily Truck Traffic (ADTT) and then determines what the governing (ultimate) load effect(s) are for all loading conditions considered. Each of the individual bridge members is to be considered in this analysis.

The final step of the analysis process involves using two more customized spreadsheets. One was developed specifically for determining the flexural and shear capacities of the plate girder configurations using the provisions of AASHTO Specification Section 6.10 adapted for the historical member configurations. The other was developed specifically for determining the axial capacities of the truss members using the provisions of AASHTO Specification Sections 6.8 and 6.9. These two spreadsheets also incorporated various general dimension and detail requirement checks as outlined in AASHTO Specification Section 6.7.
Once the ultimate loads and factored resistance for each member is determined, a comparison is made to assess if there is sufficient capacity in the member to resist the applied load. To assist in the evaluation, a safety factor against code minimums is calculated by taking the ratio of resistance capacity to ultimate load for each failure mode considered. Safety factors less than 1.0 would indicate the member does not meet the minimum degree of safety required by code under HL-93 design loading. These Safety Factors are also useful in determining how much deficiency (section loss) can be accepted before failure. A member with a factor of safety of 2.0 can theoretically have a 50% reduction in section before failure is eminent. This conclusion however must be tempered with engineering judgment when determining what the actual acceptable section loss may be.

Summary of Results:

Analysis of As-built Condition:

The results of the analysis performed indicate that the primary superstructure members would perform relatively well under HL-93 loading for Strength I load combinations, provided all deficiencies were fully restored.

In the case of the built up plate girders, shear capacities were found to be adequate, with factors of safety ranging from 1.10 to 2.77. Likewise, flexural capacities of the girders were found to be adequate. The compression flanges were found to perform with a factor of safety ranging from 1.20 to 2.80. The tension flanges were found to perform with a factor of safety ranging from 1.22 to 3.02 for gross section analysis.

When the tension flanges are analyzed for fracture at the net section, however, two girder sections were found to be inadequate by a small margin. It should be noted that insufficient information about the number, diameters, and spacing of the rivets which attach the flange plates to the girder section is provided in the documentation available. To complete this analysis, several, what are believed to be conservative assumptions were used. Field verification of assumptions used may yield more favorable analysis results.

It should also be noted that all girder sections fail to meet the Web Proportion...
limit given in section 6.10.2.1, although the margin is small (4% typically). The AASHTO commentary for this requirement indicates that the requirement was previously not applicable to girders with transverse stiffeners, but is now included so that the requirement in previous Specifications to provide additional transverse stiffeners for handling in girders with more slender webs, beyond those required for shear, is eliminated. Although not investigated, it may be possible to use older AASHTO Specifications to show that the transverse stiffeners provided are sufficient to pass the web slenderness requirements. This finding should not be considered to be significant from an analysis standpoint as the provision is for erect ability only, not for strength.

All other Cross Sectional Proportion Limits required in section 6.10.2 are passed by all girders with one exception. The compression and tension flange proportions required in section 6.10.2.2, equation 1 are exceeded by 3% for the 20 foot span girder section. The AASHTO commentary for this requirement indicates that the purpose for this limit is to ensure that the flange will not distort excessively when welded to the web. As the girder sections are built up using rivet connections, this requirement is not applicable to this bridge.

Similarly, the axial capacities for the main truss members were generally found to be adequate. The margin, however, was small in some instances. Analysis of the compression members indicates performance with factors of safety ranging from 1.01 to 23.89. Most compression members have factors of safety ranging from near 1.10 to 2.00.

Tension member analysis yielded slightly more favorable results. Members were found to have factors of safety ranging from 1.41 to 26.72 with most members performing at a factor of safety between 2.0 and 4.0.

It should be noted that traditional analysis for the truss members was performed considering axial only loads and the member’s capacity to resist those loads. The connection detailing used to construct these trusses, will in actuality, induce some fixity into the connections. This in turn will cause the members to have some bending moment in addition to the axial loading. A more detailed final design analysis will be required to determine the extent of this effect and the implications to member capacities to resist the combined effects. However, it is reasonable to infer that those
members having factors of safety near 1.0 for axial effects alone will be shown to be insufficient for the combined effects under the same HL-93 loading. Questionable members could be supplemented with reinforcing to achieve sufficient capacities.

**Evaluation of Current Conditions:**

Based upon the information derived from the As-built Condition Model, the current ability of the bridge to support the design loads can be assessed by taking into consideration the effect of section loss and deterioration of the structural elements of the bridge.

Critical members were identified from the As-built Model and the effects of assumed section loss of these members evaluated. Also, the members which had experienced the most significant section loss as identified in the MoDOT inspection reports were also considered.

Analysis of the top (compression) chord of a typical truss span, revealed that the critical section would have a theoretical axial compressive capacity of 1046 kips, assuming no deficiencies. The required axial load at this critical member under the AASHTO HL-93 design live load and self weight of the bridge structure itself was found to be 1037 kips (Factor of Safety = 1.01).

If the assumption is made that current and anticipated future deficiencies results in a 10% section loss in this critical section, the available axial compressive capacity drops to 941 kips, while the required axial load remains 1037 kips (Factor of Safety = 0.91). Therefore, this number would need special consideration for the rehabilitation of the bridge.

Alternately, analysis of the bottom (tension) chord of a typical truss span, revealed that the critical section would have a theoretical axial tensile capacity of 1532 kips, assuming no deficiencies. The required axial load at
this critical member was found to be 530 kips (Factor of Safety = 2.89).

If the assumption is made that current and anticipated future deficiencies result in a 45% section loss in this critical section, the available axial tensile capacity drops to 842 kips, while the required axial load remains 530 kips (Factor of Safety = 1.58). This means that in this deteriorated state there is still sufficient capacity to resist the full HL-93 design loading.

**Evaluation of the Gusset Plates:**

In addition to the primary member analysis of the main deck truss, two gusset plate connections were chosen for an in-depth evaluation. These two connections were selected on the basis of maximum loads in both the webbing and chord members.

To assist in the evaluation, a spreadsheet developed by the Michigan Department of Transportation “Gusset Plate LRFR Analysis V2.2” was used. This spreadsheet is based upon Federal Highway Administration Guidance Documents and AASHTO LRFD Bridge Design Specifications. The spreadsheet performs several checks including resistance of fasteners, gross section yielding, net section fracture, and block shear rupture. A rating factor based upon the AASHTO Strength I load combination is determined for each check. This rating factor compares the capacity of the connection to resist loads to the loads applied. Rating factors of 1 or greater are considered satisfactory.

The geometry input for the spreadsheet is extensive. To achieve the best accuracy the gusset plate connections were recreated in AutoCAD, a computer assisted drafting software, based upon information in the steel shop drawings. From these recreated details, precise dimensions can be determined directly. One half inch was used as the gusset plate thickness and is considered to be generally conservative based upon MoDOT inspection reports.

The spreadsheet factors loads internally, so new load combinations were created within the RISA model to determine unfactored member loads with adjustments for multiple presence and impact only. All live loading combinations were ran to determine which load combination would result in the maximum load effect in each member of
both gusset plate connections considered. Each of those combinations was then run in turn and all individual connection member forces recorded for each instance.

With the governing load combinations and respective member forces determined, each connection was then evaluated in the spreadsheet. Effectively, this checked each connection for each maximum member load condition. The lowest reported rating factor reported governs for the connection.

The first connection considered performed well. This connection is located along the bottom chord of the truss, two panels in from the bearing. It was selected for evaluation because of the high axial loads in the truss web members. Rating factors reported ranged from 1.45 to 1.16.

The second connection analyzed is located along the top chord of the truss, five panels in from the end. It was selected for evaluation because of the high axial loads in the chord members. Rating factors reported ranged from 1.26 to 0.85. However, it should be noted that the governing check in this example (Resistance of Section-Based Checks: Combined Axial and Bending Forces/Edge Buckling) is a very conservative check. Furthermore, Section 3.4 of the FHWA Guidance Document specifically states that “the application of flexural theory to the analysis of gusset plates is questionable and not required in this Guidance”. In discussing the subject with a MoDOT representative, it was determined that MoDOT policy is not to complete this check for gusset plate analysis. Disregarding this check, the resulting rating factors would range from 1.26 to 0.96.

Evaluation of gusset plate capacities is an extensive task. The two joints judged to be most likely to be problematic for this bridge were selected for purpose of this report; however, each truss connection should be evaluated in a similar fashion to determine its sufficiency. Connections with ratings below 1 may be strengthened on an individual basis. Options may include additional angle reinforcement and/or replacing the gusset plate and rivets with new higher strength materials.

Evaluation of a Pedestrian/Bicycle only use Scenario:

Strictly speaking, the AASHTO Specifications require bridges that are for
pedestrian use only, to be designed considering a 85 psf uniform loading (as opposed to a 75 psf pedestrian load in combination with the vehicular traffic loading, a 65 psf lane load) Accordingly, consideration of the full design pedestrian load over the entire area of the bridge will result in considerably more load requirement than any previous analysis. This analysis is not deemed necessary; however, as this full pedestrian load scenario is not likely to occur at any point. There are no other provisions in the AASHTO Specifications to address pedestrian only bridge loading, but the following, more likely scenario is investigated for the reader’s consideration.

In the event that the bridge is closed to vehicular traffic, and the pedestrian traffic is limited to the exterior 6 feet of bridge deck surface, the critical top chord member in a typical truss span is found to have a design force effect of 709 kips of axial compression. With no deficiencies, this member would have a capacity of 1046 kips and perform at a factor of safety of 1.48. At 10% deficiency, it would have a capacity of 941 kips and perform at a factor of safety of 1.33.

Similarly, under this proposed scenario, the critical bottom chord member would have a design force of 345 kips tension and even considering a 45% section loss, would have ample capacity at 843 kips and perform at a factor of safety of 2.44.

Evaluation of Stabilized Structure (without deck):

An important observation made during the investigation of the truss members was that the bulk of the real stresses (unfactored loads) induced in the truss members are contributed by the weight of the concrete deck. In fact, an 82% reduction in real stresses is achieved when considering the weight of the existing concrete deck removed from the truss system (no live load considered). Thus, if the concrete deck is removed, this approach would increase the life of the structure and permit time for further evaluation and funding for rehabilitation.

This analysis also highlights benefits of reducing dead load. By doing so there is an opportunity to increase the ability of the bridge to accept additional live load. Therefore, investigation of a light weight alternative decking system is strongly recommended.

There are several light weight deck alternatives that may be considered for this purpose. A cost to benefit investigation will determine if sufficient reserve capacity can be achieved economically when compared to a standard cast in place deck and steel member reinforcing.

Conclusion:

The Structural Evaluation has evaluated several scenarios from vehicular and pedestrian loading to pedestrian only to stabilization by removing the deck.
Utilizing the current design approach for new bridges, it has been demonstrated that with rehabilitation efforts focusing on replacing some of the floor beams, strengthening the lower chord members near the ends of the truss and replacing the deck the bridge could carry vehicular and pedestrian traffic. More discussion on the rehabilitation is included in the Alternatives Section of this HSR.
Part 2
Treatment & Work Recommendations

Historic Preservation Goals & Objectives
Alternatives
Work Plan
Financial Analysis
Funding Opportunities
Public Education & Input
Historic Preservation Goals and Objectives

The historic preservation goals and objectives for this report are intended to guide preservation activities for the Meramec River U.S. 66 Bridge. The objectives include encouraging wide appreciation of the State of Missouri’s cultural resources with an overriding mission of achieving supportive public policy and sustainable funding for the historic preservation of this bridge. To meet these needs, greater public awareness and understanding about historic preservation and the connection between economic development and historic preservation must be acknowledged. The following goals and objectives have been established to guide the preservation effort on the Meramec River U.S. 66 Bridge:

**Goal 1:** Encourage appropriate treatment of historic and cultural bridge resources specifically to ensure the integrity and preservation of the Meramec River U.S. 66 Bridge

Objectives: Promote the use of The Secretary of the Interior's Standards for the Treatment of Historic Properties, paying particular regard to The Secretary of the Interior's Standards for Rehabilitation (Appendix A), and the Guidelines for Bridge Maintenance and Rehabilitation based on those standards (Appendix B). Make available technical information and assistance on caring for historic bridges.

**Goal 2:** Maintain access and a complete transportation network. The existing access and transportation network should be maintained. Because resources are limited, it becomes necessary to prioritize transportation options. Closing part of the network instead of maintaining what already exists will cause decreased mobility in established areas.

Objectives: To promote a protocol that considers preservation before replacement/demolition. Follow a national transportation project selection criterion that recognizes bridge preservation activities.

**Goal 3:** Promote improved safety. Transportation projects should be aimed at increasing safety for all users, including bicyclists, pedestrians and motorists. Safety should focus on continuing to further the multi-modal network making it as complete as possible and continuing to provide access to all users.

Objectives: To emphasize safety in all elements of transportation planning and incorporate the consideration of the context of the bridge for safety enhancements for all funding programs. Enact recommendations
of the Meramec River Greenway Concept Plan for the River Ring that addresses safety concerns. Coordinate regional actions with the AASHTO’s Route 66 United States numbered bicycle route. Maintain the interconnected pedestrian network to create a more comfortable, less intimidating pedestrian environment.

**Goal 4**: Increase public awareness of the value and importance of the Meramec River U.S. 66 Bridge as one of Missouri’s significant historic resources.

Objectives: Outline a viable, coordinated, preservation education outreach program. Increase the visibility of historic bridge preservation through historic preservation organizations. Encourage interpretation of this historic site to educate the public on a broader approach. Support the development of elementary, secondary, and post-secondary programs that teach about Missouri's historic bridges as important resources. Improve awareness of and access to historic preservation information. Encourage accuracy of information about local historic bridges, places and sites.

**Goal 5**: Provide incentives to encourage historic preservation as an economic driver.

Objectives: Promote historic preservation as a successful economic development tool to maintain, enhance, and revitalize communities and to promote tourism. Seek funding from state and national sources to assist with preservation of historic properties. Support efforts to establish tax incentives at local and national levels for preservation of historic properties. Encourage establishment of incentive programs in the private and non-profit communities. Endorse special initiatives of agencies at local, state, and national levels for historic resources.

**Goal 6**: Enhance economic development. Transportation should be used to spur economic development, specifically taking advantage of tourism opportunities related to U.S. Route 66. Efficient transportation systems that are aesthetically pleasing can help spur economic development.

Objectives: To consider impacts on and opportunities for economic development in plans and projects. Create a “tool box” of economic enhancement techniques for transportation facilities.

**Goal 7**: Encourage consideration of historic bridges in the planning and decision making processes of the public and private sectors. Transportation facilities should not diminish neighborhood character and safety; bridges should be viewed as places, part of the neighborhood, not a separate entity.

Objectives: Review development projects to assure all reasonable steps are taken to protect cultural resources. Review emergency response laws and plans so that bridges receive maximum protection in the event of a disaster. Promote local preservation program efforts to maintain and enhance the community’s character. Promote the incorporation of preservation issues in
plans. Review Regional Transportation Plans for multi-modal connectivity that is conscious of “smart growth” philosophies.

**Goal 8:** Develop awareness of impacts to the region’s natural environment and historic bridge heritage resulting from transportation planning processes, projects and programs.

Objectives: To review regional planning processes, projects and programs for positive and negative impacts on the natural environment and historic heritage. Address the transportation component of current planning initiatives with regard to the Meramec Bridge’s environment, such as watershed management, recreation planning, and historic preservation.

**Goal 9:** Form new partnerships to expand and strengthen the historic preservation community.

Objectives: Support and strengthen local historic preservation efforts. Encourage historic groups to identify concerns and develop strategies to protect the bridge as a cultural resource. Encourage nonprofit statewide organizations, to promote historic preservation. Foster stewardship of cultural resources by land owners, private individuals, groups, and public agencies. Use emerging technologies to improve communication among organizations and individuals interested in historic preservation.
Alternatives

Transfer of Ownership

In order for the Meramec Bridge to remain standing, a transfer of ownership must occur. Because this is fundamental to any discussion of the future use of the bridge, it is presented here as a reference for potential interim or permanent owners to consider in conjunction with the alternatives that follow. The information contained below may act as a guide to the challenges and questions that arise during a transfer of ownership transaction.

Transfer Agreement

In accordance with applicable laws, rules, and regulations, it may be possible to transfer a historic bridge from Missouri Department of Transportation (MoDOT) to a new owner. A transfer agreement should specify the parties involved in the transfer and should transfer the responsibility for maintenance and operation to the new owner. Although specific items to include in the agreement should be considered on an individual bridge basis, it may be appropriate to consider the following for the Meramec River U.S. 66 Bridge:

- Special requirements for the reuse of the bridge (e.g., pedestrian railing geometry and capacity restrictions).
- Scope of work to be performed on the bridge, including modifications, restoration, and/or preservation, and the party responsible for such work.
- Description of any new construction needed to accommodate the Bridge at its current location or at a new site, and the party responsible for such work.
- Any environmental clearances or permits required.
- Details of funding provisions, if any.
- Schedule for completing the bridge relocation and rehabilitation.
- Provisions relating to the transfer of any real property associated with the bridge in its current or new location.
- Disclosure of hazardous material, and/or implementation of a survey to determine if the bridge includes products such as lead-based paint or asbestos.
- Transfer of existing records including design, construction, and maintenance records.
Right-of-Way Issues

Right-of-way issues are relevant for the Meramec River U.S. 66 Bridge because access to the Bridge is currently provided by a public road on public right of way. Any transfer of bridge ownership should bear in mind access to the structure for the new owner as well as intended users. This access is essential for use and for maintenance of the structure. For situations in which the transfer of on-site ownership is the preferred disposition of the structure, the successful transfer of the structure is dependent on the ability to ensure that the new owner of the bridge has access to it and that access is controlled by the disposition of the right-of-way approaches.

The statutory basis for highway right of way is described in the Missouri State Statutes, Section 226. Highway right of way in Missouri is owned by MoDOT through fee simple ownership or a prescriptive easement. Primary routes are generally held in fee simple (absolute ownership, without limitation or condition). Most secondary roads are on prescriptive easement (the right, acquired through long-continued use, to use or control property owned, usually in fee simple, by another).

The majority of Missouri’s secondary roads began as county roads, a system that dated from the days of earliest settlement and remained in place until the creation of the
state roadway system. In Missouri, the prescriptive easement for secondary roads is usually a right of way of 30 feet, which was the statutory width for county roads constructed prior to the creation of the state secondary system.

According to the Code, highway right of way is disposed through either abandonment or discontinuance, actions that have different results depending upon how the right of way is held. Abandonment not only “extinguishes” the public right of way, it also returns the underlying property to the full control or ownership by the private sector. If the right of way is a prescriptive easement, the property automatically reverts to the “owner of the fee,” usually the adjacent property owners, upon abandonment. Abandonment of right of way owned in fee simple, however, results in the formal transfer of ownership by deed. In contrast, discontinuance extinguishes the use of the property as a highway but the land remains a public right of way regardless of how it is owned. Procedures for abandonment and discontinuance of right of way are defined in the Missouri State Statues.

The transfer of ownership or responsibility for an historic bridge on its original location is influenced by the manner by which the approach right of way is held and the method by which it is disposed. If the approaches to the bridge are owned in fee simple, the approach right of way can be transferred to a private owner by deed. For situations in which the access of other private property owners must be maintained along a fee-simple right of way, the approach could be retained by and access to the bridge could be ensured by an agreement or land-use permit. Approach right of way used by prescriptive easement, however, could make transfer of bridge ownership difficult. Abandonment of prescriptive right of way would return use of the property to the “owner(s) of the fee,” and access to the bridge would be extinguished. Discontinuance of an approach used by prescriptive easement would ensure that the successor owner of the bridge has access to it. That access, however, could not be controlled or limited since the approach would remain a public way.
Rehabilitation

The Meramec River U.S. 66 Bridge is a good candidate for rehabilitation because it not only satisfies a transportation need, but it completes the transportation network, making a critical connection across the Meramec River. The connection completes the vehicular travel network by providing a link that enhances the viability of the Route 66 Park and adds to the Route 66 experience in Missouri. This is important for this bridge because of the significance of its connection with Historic U.S. Route 66, and the automobile. The bridge also completes the multi-modal transportation network connecting hundreds of miles of trail with the river crossing.

Considerations for Maintenance and Maintaining Historic Integrity

For the Meramec River U.S. 66 Bridge, as with many historic bridges, the focus of maintenance and rehabilitation work should be on maintaining the historic integrity of the bridge. To meet this objective, maintenance and rehabilitation work should be conducted using the Secretary of the Interior’s Standards for Rehabilitation in Appendix A. The figure shows relative costs of maintenance, rehabilitation, and repair work that contribute to the preservation of historic bridges.

With rehabilitation, the Meramec River U.S. 66 Bridge can fulfill a transportation need.
Because many historic bridges were designed with narrower roadway widths and lower load limits, they often have difficulty meeting current design standards. Federal and state policies recognize that existing bridges with less than desirable geometric criteria (width, horizontal and vertical alignments) can be retained. The Meramec River U.S. 66 Bridge is unique in the fact that the approach alignment, bridge width and vertical clearance are adequate to meet the current design standard criteria.

Rehabilitation of Structural Components

From the findings and analysis of the Meramec River U.S. 66 Bridge, the major items of work that are needed to maintain vehicular and pedestrian use include:

Superstructure

The superstructure may be repaired, but cannot be replaced without detrimental effects on the historic bridge. The superstructure of the Meramec River U.S. 66 Bridge is one of the character-defining elements of the historic bridge. The elements of the bridge that are deteriorated may be repaired or replaced as needed. The repair or replacement of these elements should be performed in a manner that preserves the original appearance of the element. Some of the options available are present in Appendix C – Examples of Superstructure Work – offers suggestions for work that may be done to rehabilitate or repair the Meramec River U.S. 66 Bridge.
For this Bridge the primary concerns are the deterioration and section loss which has occurred in the bottom chords of the trusses near the ends. The figure below shows how this issue can be addressed by strengthening the member with angles. The angles act provide additional steel area to the location where rusting has caused section loss. This approach could also be used on the vertical members at the ends of the truss as well. No other rehabilitation is anticipated for other truss members. Some repairs to bracing and other miscellaneous members may also be necessary.

The other superstructure component to be replaced is a number of the floor beams have experienced severe deterioration and some form of buckling or cracking. These floor beams would be replaced with new floor beams. It is anticipated that approximately 25% of the floor beams would be replaced.

Bearings

While rehabilitating the bridge, it is important to service the bearings. No major repairs are expected. This work would consist of replacing missing nuts, cleaning any pack rust that has collected and cleaning any debris which has accumulated in these locations.

Substructure

The deficient substructure for this bridge can be repaired and/or rebuilt without detrimental effects on the historic bridge. For this bridge, the substructure is not a character-defining feature of the historic bridge. This is typically the case for types with a substructure that is not integral with the Superstructure.

The substructure repairs would consist of removing unsound concrete on the columns and the caps to sound material, cleaning, replacing reinforcing steel and forming the area to receive new concrete. This work would be consistence with work which has been done on the bridge in the past.

Traffic Railing

There are some portions of the railing system that are in need of repair and/or replacement. For this bridge, the railing is attached to the floor beams, thus it is integral with the superstructure. Special consideration must be given toward
maintaining the bridge’s historic integrity under these circumstances.

The railing would be reused to the maximum extent possible and where necessary replaced with similar material.

Deck

The deck of the bridge is in very poor condition and is in need of replacement. It has been accepted that a deficient deck can often be replaced without detrimental effects on the historic bridge. To reduce a bridge’s dead load, it may be possible to replace the deck with a deck of lighter weight.

The rehabilitation of the bridge would include full removal of the bridge deck. This would allow for the replacement of the floor beams. Then, a new deck could be poured. It is recommended that use of lightweight decking material, such as carbon fiber composite material, or various light-weight concrete systems for deck replacement be considered. As previously discussed, the deck uses a lot of the capacity of the bridge which is replaced with a light-weight deck could provide additional capacity for live load (vehicular loads).

Other Alternative Uses

When a historic bridge cannot meet a vehicular transportation need, other uses for the bridge should be considered. Other uses of the historic bridge at the existing site or at a new site may be considered preservation
options if a viable alternate use for the bridge can be found. Most important to the bridge is prioritizing alternatives that first preserve the location and historic integrity of the bridge to the greatest degree possible.

It is recognized that the reuse of a bridge at the existing location is preferred if it does not have an adverse effect or if there is no longer a transportation need at the site. However, this is not the case for the Meramec River U.S. 66 Bridge.

If the bridge cannot be rehabilitated, the bridge could remain in place, but no longer carry traffic. Another option is to reuse the bridge at a new location. This may be possible if an appropriate location and willing new owner can be found. It has been discussed that the bridge or portions of the bridge could be placed in the Route 66 State Park, providing visitors the opportunity to experience the structure as a monument. Analysis of the feasibility of reuse options should be done on an individual project basis. However, some considerations for reuse options are provided below.

**Bicycle/pedestrian traffic**

Since the bridge is on an established bicycle/pedestrian route, it may be possible to carry non-vehicular traffic across the historic bridge. In considering this option, much of the same work as recommended for both vehicular and pedestrian/bicycle traffic would still be required. There could be some advantages realized with this alternative if the pedestrian traffic is restricted to a 12-foot pathway. The figures below show two alternative layouts which could provide this type of configuration.

See the Structural Evaluation section of this HSR for more information on the loading restrictions for this alternative.

With the interior path, light maintenance and emergency vehicle access could also be provided.
Recreational viewing platform

Another unique opportunity with this bridge would be to provide a viewing point for adjacent natural or man-made features that exist along this stretch of the Meramec River and are of interest to the local population and tourists.

Fishing pier

Under certain circumstances a bridge may be reused for a fishing pier. This would be difficult at this location, primarily due to the height of the structure above the Meramec River. However, provisions could be made to incorporate access from the bridge via a ramp or stairway to a lower elevation closer to the river.

Adapt as building

In some cases, a bridge may be adapted to serve a new role. Portions of the bridge could be converted to a building, such as a store or museum. This type of adaptive reuse may be eligible for Transportation Enhancement (TE) funds for museum development, for instance, if the museum is tied to a transportation theme.

Superstructure Replacement

Although the Secretary of the Interior’s Standards for Rehabilitation (Appendix A) calls for the continued use of historic bridges, in cases where this is not feasible, selection of a new superstructure of the same basic type may be appropriate. For example, a historic truss could be replaced with a newly constructed truss. It is recommended that the new bridge be similar in scale and type to the one it replaces.

Build a New Bridge from Salvaged Pieces

In select cases, it may be possible to reuse elements of a historic bridge on a newly constructed bridge, allowing some of these components to be preserved by use on the new structure. This could occur with a new bridge at this location or an alternate location.
Stabilize and Close

Another consideration for evaluation is that if the bridge does not fulfill a transportation need at the site and it is not feasible to relocate the bridge to a new site due to structural limitations, lack of funding, inability to identify a viable new owner, it may be possible to close the bridge to traffic, stabilize the bridge, and leave it standing. In this situation, certain measures would need to be adopted to reduce liability and to monitor the condition of the bridge. Minimal maintenance (washing and spot painting) and periodic inspections should continue. The bridge closure should be clearly posted and a vehicle barrier should be installed to limit pedestrian and vehicle access to the bridge. In addition to prolonging its life, removal of the bridge deck may also be appropriate as a means of limiting access to the structure.

Monument

All or part of a bridge may be relocated to a public access location to serve as a monument to engineering and/or cultural heritage. Some bridges have been converted into historical exhibits in public parks.

Move to private property

Occasionally, new owners are interested in moving a bridge to their private property. Bridges can be used on a private road or driveway to span a creek, or as a commercial draw for economic benefit.
The Meramec River U.S. 66 Bridge is a unique community resource. It is historically significant at the local, state and national levels and retains a very high degree of integrity. The bridge derives this historical significance from its place within the rich history of U.S. Route 66 and its contribution to American society. The Meramec Bridge’s age has not lessened its value in that it remains an exceptional artistic and community accomplishment. However, as indicated in the structural evaluation, the bridge must be repaired to address the deferred maintenance issues and be placed back into service.

The work plan presented here is intended to outline the timeline with regard to the transfer of ownership that must occur in order to preserve the bridge for future generations. In summary, ownership, temporary or permanent, of the Meramec River U.S. 66 Bridge must be transferred from Missouri Department of Transportation (MoDOT) by February 2012. A temporary owner can hold the bridge for a maximum of four years, until February 2016, at which time either the bridge must be transferred to a permanent owner, or returned back to MoDOT for demolition.

According to MoDOT, from February 2012, a temporary owner would have four years to raise funds through capital campaign, donations or grant applications, etc. Additionally, MoDOT has set aside $600,000 in funds they have earmarked for the bridge. The agency has indicated that these funds can be used by the new interim or permanent owner on the rehabilitation of the bridge, or if a new owner is not found, the funds will be used to tear the bridge down.

If a new owner raises funds, the money raised would go toward the rehabilitation of the bridge or toward the pursuit of an option for one of the other alternatives shown on the graphic work plan following this page. The alternatives are also described in the section of this Report entitled Alternatives. All of the alternatives listed in the work plan will require repairs that can be accomplished in such a way so as to retain some of the integrity of the Meramec Bridge and all will take varying amounts of time to accomplish.
WORK PLAN

February 2012

Temporary Ownership Transfer from MoDOT
Capital Campaign
Evaluate Funding

February 2016 Identify Permanent Owner

Demolition
- Return to MoDOT for Demolition
- Bid Documents
- Demolition
- Completion

Options

Alternatives
- Bicycle/Pedestrian
- Recreational Viewing Platform
- Fishing Pier
- Superstructure Replacement
- Adapt as Building
- New Bridge Using Salvaged Parts
- Stabilize and Close
- Transfer to Private Owner

Rehabilitation For Vehicular Traffic
- Design/Permitting
- Construction
- Completion/Ribbon Cutting
Financial Analysis

Qualifier Statement

The opinions of probable costs provided below have been prepared in 2011 dollars. The costs were developed without benefit of preliminary construction plans and are based on the findings included in this report. Using engineering judgment and/or gross estimates of quantities and historic unit prices from past project bid tabulations and are intended to provide a programming level of probable costs.

Refinement of the probable costs is recommended once more detail from preliminary plans has been developed. The estimated preservation costs include a 20% contingency and 7% mobilization allowance for the preservation activities, excluding soft costs. Actual costs may vary from the opinion of cost provided herein.

<table>
<thead>
<tr>
<th>SUMMARIZED COSTS</th>
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<tbody>
<tr>
<td><strong>Annualized Routine Cost:</strong></td>
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<tr>
<td>Maintenance Cost:</td>
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<tr>
<td>Trim/Remove Vegetation:</td>
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<tr>
<td>Fracture Critical Inspection:</td>
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<tr>
<td>Load Rating Analysis:</td>
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<tr>
<td>Insurance:</td>
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<tr>
<td>Administration:</td>
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<tr>
<td><strong>Total Annualized Cost</strong></td>
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<tr>
<td><strong>Rehabilitation Activities (Not Annualized):</strong></td>
</tr>
<tr>
<td>Superstructure:</td>
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<tr>
<td>Substructure:</td>
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<tr>
<td>Deck:</td>
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<tr>
<td>Mobilization:</td>
</tr>
<tr>
<td>Other:</td>
</tr>
<tr>
<td>Design/Construction Service:</td>
</tr>
<tr>
<td>Contingency:</td>
</tr>
<tr>
<td><strong>Rehabilitation Cost:</strong></td>
</tr>
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# Opinion of Probable Construction Cost

**Engineer:** GRA  
**Date:** 11/14/2011  
**Location:** Meramec River Bridge - Route 66  
**Primary Repair Strategy:** Rehabilitation

<table>
<thead>
<tr>
<th>Work Item</th>
<th>Quantity</th>
<th>Dimension</th>
<th>Unit Cost</th>
<th>Total</th>
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<tbody>
<tr>
<td><strong>New Deck</strong></td>
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<tr>
<td>Removal of Existing Bridge Deck</td>
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<td>$317,520.00</td>
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<td>$25.00/SF</td>
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<td><strong>Superstructure Repair</strong></td>
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<tr>
<td>Removal of Expansion Joints</td>
<td>504.0</td>
<td>LF</td>
<td>$250.00/LF</td>
<td>$126,000.00</td>
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<tr>
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<td>504.0</td>
<td>LF</td>
<td>$420.00/LF</td>
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<td>6&quot; Pavement Markings</td>
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<td>Replace Floor Beams (25 beams)</td>
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<td><strong>Contingency (20%)</strong></td>
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<td><strong>Design &amp; Construction Phase Services (16%)</strong></td>
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<td><strong>Construction Total</strong></td>
<td></td>
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<td>$11,039,000.00</td>
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</table>
Funding Opportunities

The majority of funding for the rehabilitation and reuse of historic bridges is available through Federal Highway Administration (FHWA) federal funding programs. The legislation authorizing the various federal funding programs is named the Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The SAFETEA-LU available funding programs and the applicability of those different funding programs are discussed below.

The current status of Federal Highway Program funding is given below. This information is important to understand, because without having a well defined Federal Highway Program and funding, it becomes difficult to establish a clear path of potential funding and opportunities for Federal and State participation.

Since the current highway law (SAFETEA-LU) expired on Sept. 30, 2009, the highway program has been operating under a series of eight short-term extensions. The uncertainty surrounding reauthorization has hit the transportation system hard. Without a clear sense of what resources will be available for future investment, states have not been able to plan major new projects.

In December 2009, as a part of the much larger FY2010 Defense appropriations bill, President Obama signed into law another short-term extension of SAFETEA-LU programs and funding. Unless the White House, the Senate and the House give priority to this matter, a long-term highway bill authorization will be put off until 2012 or beyond.

Recent highway program extension expiring on March 31, 2012, the House and Senate have yet to introduce highway reauthorization legislation.

It has been discussed that a multiyear surface transportation reauthorization bill will be introduced "in the coming weeks" and "hope to move the legislation through the House before the end of the year". The bill is expected to provide funding levels to be at or above current levels.

Numerous proposals have been discussed publically. House Transportation and Infrastructure Committee Chairman John Mica, R-Florida, had been under instruction from House leadership to limit a six-year reauthorization bill to funding levels that could be supported by existing revenue into the Highway Trust Fund. That would result in a cut of roughly one-third in federal highway and transit spending compared to
the current annual level. Mica has since discussed keeping the prior six-year funding level.

While the Senate Environment and Public Works Committee has to mark up a two-year surface transportation reauthorization measure. The legislation would authorize highway and transit spending of $109 billion for the two-year period.

National Highway System Funds

These funds are available for work on the National Highway System (NHS). NHS funds may be obligated for any of the following projects:

- Bridges undergoing a rehabilitation that includes improvements for bicycle and pedestrian use.
- Construction, reconstruction, resurfacing, restoration, and rehabilitation of segments of the NHS.
- Operational improvements for segments of the NHS.
- Construction of, and operational improvements for, a federal-aid highway not on the NHS.

Highway Bridge Replacement and Rehabilitation Program Funds (HBRRP)

HBRRP funds are available to replace or rehabilitate deficient or functionally obsolete bridges if certain criteria are met. FHWA also allows HBRRP funds to be used for preventive maintenance.

HBRRP funding typically provides an 80% federal contribution to a bridge project, with the additional 20% matched by the state and/or local government. If the project is not state sponsored, the additional 20% is the local government's responsibility. HBRRP funds may be used to rehabilitate a historic bridge either for continued vehicular use or for non-vehicular use. If a bridge is not being retained for vehicular use, certain limitations apply.

1. Rehabilitation for Vehicular Use

If a historic bridge can still meet a transportation need, HBRRP funds may be applied when planning a rehabilitation project.

According to FHWA guidance, preventive maintenance on federal-aid highway bridges is eligible for funding under the HBRRP if the state demonstrates to the satisfaction of the Secretary of Transportation that the activity is a cost-effective means of extending the bridge’s useful life.

2. Rehabilitation for Non-Vehicular Use

HBRRP funds for non-vehicular use are not to exceed costs of demolition as per Title 23 Section 144(o) of U.S. Code, "Historic Bridge Program." Federal funds are available pursuant to Title 23, Section
144(o) for the rehabilitation of historic bridges for non-vehicular use. If the bridge is no longer carrying motorized traffic, money is available up to the cost of demolition of the bridge. It is important to note that use of these funds precludes future use of Transportation Enhancement (TE) funds for work on the bridge. On reuse projects, SAFETEA-LU (and successor funding) funds can and should be used prior to the use of HBRRP funds. The use of TE funds and Successor Funds is discussed below:

Use of Transportation Enhancement (TE) Funds (and Successor Funding)

The Federal Government has historically set aside 10% of a state's federal transportation dollars for transportation enhancement projects. Funds are available through the TE program for historic preservation activities, including bridge rehabilitation. TE funds can be used to rehabilitate historic bridges for both vehicular and non-vehicular uses. Unlike HBRRP funding, the use of TE funds does not preclude the use of other federal funding. For project planning purposes, use of these funds prior to an application for HBRRP funds will maximize the federal assistance for rehabilitation of a historic bridge.

The SAFETEA-LU program, like HBRRP, includes 80% federal funding with the remaining 20% a mixture of state and local funds. Local governments have the option of contributing their match in local dollars, otherwise referred to as a "hard" match. A "soft" match option allows local governments to provide their portion of funding through three alternate methods:

- They can choose to provide their portion of the match by applying other federal funds, such as Housing and Urban Development or Environmental Protection Agency money.
- They can use a non-FHWA-funded transportation-related expenditure, such as a storm sewer upgrade, as the match.
- The value of local and state government services, materials, and land utilized for the project and the costs of preliminary engineering prior to project approval may be credited to the state and local match.

Capital Campaigns, Deferred Gifts and Endowments

Other options to gaining funds for the Meramec River U.S. 66 Bridge include conducting a capital campaign to raise funds for the Bridge.

A capital campaign raises money that will be spent to acquire or improve a physical asset, in this case the Meramec River U.S. 66 Bridge. The purpose of a capital campaign for the Bridge would be to raise funds to be spent on the one-time expenditure of rehabilitation.
The capital campaign should set a goal to raise the amount of money projected for the construction costs as well as to cover some of the expenses incurred to conduct the campaign. The capital campaign should be targeted as a large-donor campaign. In that regard, the following rule of thumb applies: Plan on raising at least one-third of the goal from 10 to 15 donors, a second third from an additional 75 to 100 donors, and the final third from the rest.

Because they rely heavily on large gifts to raise a substantial amount of money, capital campaigns draw their volunteer leadership and solicitors from the upper end of a community’s business and civic leadership. The high visibility of a capital campaign raises the stakes considerably. Few situations are more damaging to the image of an organization than announcing the planned construction of a project and then failing to raise the money to get it done.

Though a capital campaign will likely run longer than an organization’s annual campaign, it should usually be wrapped up within a year, eliminating the risk of carrying over into successive annual campaigns. Ideally, the money to pay for the bridge rehabilitation should be in hand before the ground-breaking for the project. On the other hand, a ground-breaking is often an effective fund-raising event, and taking prospective donors to a construction site or showing them the Bridge may be particularly compelling.

Capital campaigns often offer naming opportunities. In the case of the Meramec River U.S. 66 Bridge, some creativity would need to be applied if naming rights were considered. Typically, a donor need not necessarily cover the entire expense of a capital project in order to be offered a naming opportunity. When a potential donor is considering making a gift that is far and away the largest donation to a capital campaign and when that gift is truly a substantial portion of the total expense of construction, then offering naming rights may be both appropriate and persuasive.

Another kind of gift that could be solicited during a capital campaign is in-kind goods and services. Although organizations would generally rather have cash than any other kind of gift, capital campaigns are one of the few instances where there is no difference between cash and in-kind gifts. It is important to give public credit for the cash value of an in-kind gift. The IRS won’t let the donor deduct that amount, but public acknowledgement of what the gift was worth to the organization, what it would have cost “retail” should be cited.

During a capital campaign for the Meramec River U.S. 66 Bridge, cash gifts should be encouraged over deferred giving since the money being raised is money that needs to be spent on improvements in the near future. While the offer of a deferred gift poses no problem other than timing to those seeking to build an organization’s endowment fund, fund-raisers seeking cash for the capital
project should be ready with a plan for accepting deferred gifts.

There may be a way to turn a deferred gift into endowment funds to help with the future expense of maintaining the Bridge. The primary difference between capital and endowment funds is that capital funds are not retained and invested to yield income like endowment funds. Endowment funds can be raised, held and invested to cover ongoing, operational and maintenance expenses, or to fund special projects for the Bridge. Building an endowment for the Meramec River U.S. 66 Bridge reduces the pressure on future annual campaigns to raise the additional operating and maintenance money that will be needed to maintain the Bridge.

An organization which undertakes an endowment campaign does so in order to lessen its need either to raise money each year to cover any operational deficit, or to raise money for occasional extraordinary expenses. Income earned on money placed in an endowment fund is restricted to the purpose of that fund, and the fund is not easily invaded. Usually, an organization’s bylaws make it hard, if not impossible, for the organization to spend endowment.

Since the money being raised in an endowment campaign is to be invested for future income, the goal should never be small. The effort required for an endowment campaign is too great to justify a result that when invested will yield only a few thousand dollars of yearly income.

The base for any successful fund-raising campaign is an attainable goal, a plan for getting to that goal, and the tools to execute that plan. But in the end, the success or failure of a fund-raising campaign hinges on leadership, and that leadership starts with a plan of action.

Raising funds to rehabilitate the Meramec River U.S. 66 Bridge is about more than money. It is about preserving history, protecting American heritage, maintaining the transportation network, serving people and many other worthy causes. It is easy to understand that the concern to raise the funds to get the project accomplished often becomes the front and center issue and discussions center on dollars. But, we must never let the need for money obscure, or put too far into the background, the reasons the project should be accomplished.
Public Interest and Benefit and Educational Opportunities

PUBLIC INTEREST AND BENEFIT

The June 2011 Federal Highway Administration (FHWA) monthly newsletter, Successes in Stewardship states, “Historic bridges enhance a community’s character and are an important part of the United States’ transportation infrastructure. Historic bridges can provide particular benefits to communities. Planners and transportation officials note that historic bridges often have unique and context-sensitive designs, fostering a sense of place as a monument to a community’s history. Additionally, historic bridges are typically narrower than newer bridges and therefore can function as traffic-calming devices, as drivers tend to reduce speeds in narrower lanes. Residents and business owners often express appreciation for how historic bridges reduce traffic speed, especially when bridges serve as gateways to community centers. Preserving historic bridges can also provide environmental and economic benefits; agencies can reduce waste and yield significant cost savings by rehabilitating instead of replacing historic bridges.”

The FHWA clearly recognizes the importance of historic preservation of bridges like the historic Meramec River U.S. 66 Bridge. The benefits stated in the excerpt from the article above are only a few of the benefits to the public. In the case of the Meramec River Bridge, the impact reaches much further than the immediate surrounds. Because the bridge is an intrinsic resource for U.S. Route 66, the impact of this bridge is international in nature. The bridge is irreplaceable to the 250,000 annual visitors to the Route 66 State Park, and though there is an understanding by those most familiar with the bridge, broader public education and input is necessary to continue to spread the word.

A primary goal of an ongoing public education and input process is for it to serve as a central component of the planning, priority-setting, development, and dissemination system for the Meramec River U.S. 66 Bridge. These public processes allow for understanding and responding to complex problems and situations. By harnessing the collective wisdom of people who are stakeholders in the situation, critical needs can be identified and priorities can be developed.

A grant from the National Trust for Historic Preservation helped to fund the development of a public education campaign. The Meramec River U.S. 66 Bridge was identified as a preservation project through a program launched as “Show the Love” for
the Meramec River Route 66 Bridge. This campaign is promoted through a website developed during the course of the project: http://meramecriverrt66bridge.greatriv.com/ provides a historical overview, educational talking points, and a connection to stakeholders, the public, and all interested parties. Additionally, the website promotes fund-raising and marketing materials. In great part the public education campaign heightened awareness and laid the groundwork for this Historic Structure Report for the Bridge funded in part by the National Park Service’s Route 66 Preservation Program.

The “Show the Love” Campaign educates and engages the public in historic preservation efforts in an effort to raise community, regional and national awareness of the importance of the Meramec River U.S. 66 Bridge as well as providing an outlet for donations for funds to save the bridge from demolition. In addition to education, the website provides a mechanism for collecting ongoing public input. Both public and private stakeholders have an opportunity to log opinions and ideas for the preservation of this historic resource. The website stimulates community interest to take action and serves as an educational conduit to demonstrate the importance of preservation of our historical community and national resources.

While the Meramec River U.S. 66 Bridge is the subject of this report, there are many other historic bridges in Missouri that can benefit from public education and input strategies. As part of the effort to ensure that Missouri’s historic bridges have the best possible chance of survival, outreach programs can be established to encourage maintenance, rehabilitation, and reuse of historic bridges. Education and outreach for bridge owners, design professionals and other decision-makers (e.g., local government officials) will help to raise awareness for the options available for retaining these bridges. The maintenance, rehabilitation, and reuse of historic bridges should be promoted at different venues in order to reach bridge engineers, design professionals, decision-makers, and contractors. The following programs and concepts highlight some of the most viable opportunities for educating the public and gathering input and insight on historic preservation of bridges.

**Local Roads Program**

The Local Roads Program is a center established by FHWA’s Local Technical Assistance Program. The program provides training, technical assistance, and information to municipal officials and employees responsible for the maintenance,
construction, and management of local roads and bridges in Missouri. Services provided by the Local Roads Program include:

Training programs

The primary service offered by the Local Roads Program is training targeted to all highway and public works agencies in Missouri by direct mailings. Training courses on a variety of technical and management topics are offered to accommodate the needs of highway personnel and other municipal officials. Currently, the Program does not offer a course focusing on historic bridge issues.

School for Highway Superintendents

The School is offered annually and features short sessions of general interest as well as specialized workshops.

Technical Assistance Program

The program's Technical Assistance Administrator can provide technical assistance relating to pavement maintenance, drainage, road rehabilitation, and administrative topics. Referrals to someone qualified to address specific issues can also be provided.

Library Resources

The information library is composed of publications, videotapes, computer software, and CD-ROMS from a variety of sources on numerous topics. Materials are available to local highway and public works officials and municipal employees, either free of charge or by loan.

Conferences

Conferences provide an opportunity for owners, design professionals, and other decision-makers (e.g., local government officials) to exchange ideas on successes, failures, and emerging technologies available for bridge maintenance and rehabilitation projects. The most relevant conference sessions presentations should highlight maintaining and rehabilitating historic bridges in the state and should offer guidance to local governments as they pursue options to retain their historic bridges.

In Missouri some of the most significant conferences providing opportunities for relevant information include:

Transportation Engineers Association of Missouri (TEAM) Conference promotes the advancement of knowledge in transportation design, construction, maintenance and operations, along with the promotion of all matters and interest pertaining to the welfare of public transportation in Missouri.
Missouri Municipal League (MML) The League's basic goal is to strengthen cities through unity and cooperation. Missouri Association of Counties (MAC) provides assistance to its member counties in matters pertaining to local, state, and federal government activities. Most pertinent to bridge preservation:

- conducting research and studies useful to county government;
- by providing a forum for the interchange of ideas among county officials;
- by providing training and educational resources during annual conferences;

Missouri Association of County Transportation Officials (MACTO) focuses on County and other local government employees involved with construction or maintenance of roads and bridges in the state of Missouri

**Design Professional Training Programs**

Training programs also provide an opportunity to disseminate available information on historic bridge preservation issues and emerging technologies. Design Professionals and contractors should be encouraged to attend training programs on historic bridge maintenance and rehabilitation.

**New Training Programs**

Additional training programs could be developed through available federal grants. Grants of up to $25,000 are awarded annually by the National Center for Preservation Technology and Training (for additional information see [http://www.ncptt.nps.gov](http://www.ncptt.nps.gov)). These funds could be used to develop a training program to promote the maintenance and rehabilitation of Missouri historic bridges. The training could be given in several locations across the state to encourage attendance by local bridge owners and design professionals. The training program should include a brief overview of historic bridges and an explanation of why it is important to preserve them. The focus of the training should be on the "nuts and bolts" of bridge preservation, providing specifications for how to maintain and rehabilitate bridges while retaining their historic integrity.

**Publications**

Another possible use of grant money is for the production of a publication on historic bridge maintenance and rehabilitation. This type of manual could provide additional specific guidance on maintaining and rehabilitating different types of historic bridges. The publication could be used as a reference guide for design professionals and local governments who own historic bridges.
EDUCATIONAL OPPORTUNITIES

Creating Public Support and Raising Awareness with the General Public

Support for saving bridges should be cultivated in the public realm with the general citizenry, as well as among design professionals and government officials. Too often the public does not become involved in the maintenance and preservation decisions for their bridges until a bridge is slated for replacement. Raising awareness of the importance of historic bridges in communities may increase local support for bridge maintenance and rehabilitation, and increase the chances of historic bridge survival.

Assistance for creating additional public support for saving historic bridges can be obtained from public agencies that have specialized knowledge in historic preservation. Agencies and organizations, such as the State Historic Preservation Office (SHPO) can help develop and/or sponsor public programs. Outreach efforts conducted by the SHPO could provide the public with a greater understanding of the importance of maintaining and rehabilitating their population of historic bridges and the available grants to accomplish preservation goals. Some potential public programs are listed below:

Develop School Programs

Discussions of historic bridges could be incorporated into the curriculum of school programs. School children could learn about the history of bridge engineering during Engineers Week, an event designed to introduce students to the importance of engineering. Engineers' Week is sponsored primarily by the American Society of Civil Engineers, which chairs the National Engineers' Week Committee of sponsors. Other supporting sponsors include Federal Highway Administration (FHWA), Missouri Department of Transportation (MoDOT), American Public Works Association (APWA), Local Contractors Associations, American Society of Landscape Architects (ASLA), and American Planning Association (APA).

Produce Informational Pamphlets

Informational pamphlets could be created for distribution at public meetings, museums, libraries, and highway rest stops. The pamphlets could include information about the results of the Historic Bridge Inventory. The benefits of preservation to communities, with examples, could also be discussed.

Publicize Bridge Rehabilitation Success Stories

Success stories about successful rehabilitation projects could be publicized through the SHPO, Local Historical
Societies, and MoDOT websites; newsletters and in local newspapers.

Presentations and Public Programs can be presented to local Historical Societies and Preservation Groups as well as Chambers of Commerce and other local business groups. Public programs could be used by local historical societies to mount bridge exhibits, highlighting a community's or county's bridges. Additional programs, including public talks, forums and open houses could also be coordinated through these groups.

Public education and input is an essential and integral part of any historic preservation plan development process, but with regard to historic bridges in Missouri, where the public is less familiar with bridge preservation, it is critical. Done well, it can improve the knowledge base for decisions, clarify the nature and extent of agreements and disagreements (e.g., among participants and between participants and agencies), and yield more widely accepted decisions (National Research Council, 1989, 1996). In the case of the Meramec River U.S. 66 Bridge, public education and input can help leaders better understand the public's view of preservation and rehabilitation issues and help stakeholders better understand critical action plan items.

Clearly, the public is intensely interested in the Meramec River U.S. 66 Bridge. There is broad agreement among the public, not-for-profit agencies, preservation organizations, historical societies, the National Trust for Historical Preservation, and the National Park Service that investing in the preservation of this bridge is the right thing to do. Based on the record, Americans hold high expectations for the future economic development of the Route 66 corridor, where the Bridge resides. That economic development will ultimately provide the return on investments made in public lands and infrastructure such as bicycle and walking paths, hiking trails, water recreation, roads, and bridges.
References & Appendices

Sources of Information for Report Summary
Sources of Information for Part 1 and Part 2
List of Appendices
Sources of Information


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Appendices

List of Appendices
Appendix A

Secretary of the Interior’s Standards for Rehabilitation

The Secretary of the Interior’s Standards for Rehabilitation are basic principles created to help preserve the distinctive character of an historic building and its site, while allowing reasonable change to meet new needs. The Guidelines for Bridge Maintenance and Rehabilitation based on the Secretary of the Interior’s Standards is included in Appendix B. These guidelines illustrate how the Secretary’s Standards have been adapted to the needs of maintaining and rehabilitating historic bridges and may provide additional information for owners pursuing such projects.

1. A property shall be used for its historic purpose or be placed in a new use that requires minimal change to the defining characteristics of the building and its site and environment.

2. The historic character of a property shall be retained and preserved. The removal of historic materials or alteration of features and spaces that characterize a property shall be avoided.

3. Each property shall be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or architectural elements from other buildings, shall not be undertaken.

4. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.

5. Distinctive features, finishes, and construction techniques or examples of craftsmanship that characterize a property shall be preserved.

6. Deteriorated historic features shall be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature shall match the old in design, color, texture, and other visual qualities and, where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

7. Chemical or physical treatments, such as sandblasting, that cause damage to historic materials shall not
be used. The surface cleaning of structures, if appropriate, shall be undertaken using the gentlest means possible.

8. Significant archaeological resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.

9. New additions, exterior alterations, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

10. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.
Appendix B

Guidelines for Bridge Maintenance and Rehabilitation
Based on the Secretary of the Interior's Standards

Secretary of the Interior’s Standards to address the special requirements of historic bridges and to identify specific applications of the standards to historic bridges. These guidelines may provide useful guidance to anyone involved in a bridge maintenance and/or rehabilitation project.

1. The original character-defining qualities or elements of a bridge, its site, and its environment should be respected. The removal, concealment, or alteration of any historic material or distinctive engineering or architectural features should be avoided.

2. All bridges shall be recognized as products of their own time. Alterations that have no historical basis and that seek to create a false historical appearance shall not be undertaken.

3. Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.

4. Distinctive engineering and stylistic features, finishes, and construction techniques or examples of craftsmanship that characterize an historic property shall be preserved.

5. Deteriorated structural members and architectural features shall be retained and repaired, rather than replaced. Where the severity of deterioration requires replacement of a distinctive element, the new element should match the old in design, texture, and other visual qualities and where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.

6. Chemical and physical treatments that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the most environmentally sensitive means possible.

7. Significant archaeological and cultural resources affected by a project shall be protected and preserved. If such resources must be
disturbed, mitigation measures shall be undertaken.

8. New additions, exterior alterations, structural reinforcements, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.

9. New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.
Beams/Girders

Beam or girder bridges have become a prevalent bridge type in the United States in the twentieth century. The terms beam and girder are interchangeable as girder simply refers to a large beam of metal or concrete. Based on the post and lintel structural system, the earliest simple beam bridges were constructed of timber and often consisted of a plank stretched over a waterway supported by a basic pier or block system. Using the same structural form as the simple beam structures, multi-girders are structures consisting of a series of steel or concrete beams placed parallel to traffic, supporting the roadway directly on their top flanges. Beam and girder bridges are supported by abutments at the ends of the bridge. The placement of intermediate piers allowed for an almost unlimited total overall bridge length. Limits on shipping, splicing, and girder depths dictated the maximum unsupported distance for this type of construction. As material technology advanced, the favored materials for beam and girder bridges became steel and concrete.

Steel/Pre-Stressed Concrete Girders

Steel or pre-stressed concrete structures may be strengthened by adding intermediate girders. The deck would need to be replaced for this option. Steel girder structures may also be strengthened by augmentation, such as through adding cover plates. Pre-stressed concrete girders could be strengthened by post-tensioning.

Trusses

A truss uses diagonal, vertical and horizontal members to support the deck loads. The members are joined with plates and fasteners (rivets or bolts) to create several rigid triangular shapes. This configuration allows relatively light units to be created for large spans.

There are three basic arrangements of trusses – pony, through, and deck – and a wide variety of types. The arrangement is called a pony truss (or, less commonly, a low truss) when the structural system lies alongside the deck. A through truss may also be referred to as an overhead truss. In the case of a deck truss, the entire truss is below the roadway. The roadway itself is usually supported by a system of longitudinal and transverse beams supported by the truss.
Various truss configurations are found in Missouri, with different types selected based on the span length that was needed. The continuous and cantilevered design approach also produced changes in the range of spans for trusses.

Truss bridges generally need to be temporarily supported to replace any deficient or deteriorated members. In cases where the members are left in place and are being augmented or strengthened by post-tensioning the truss could be rehabilitated without having to provide temporary supports. The following presents discussion on strengthening or replacing the primary elements of truss bridges. The discussion applies to both steel and timber truss bridges.

Lower Chord

This normally tension member is fracture critical. If it fails, it tends to fail catastrophically. The failure of this member could cause the entire bridge to collapse. These members can be replaced with a new member or they can be strengthened by augmentation, including post-tensioning. Post-tensioning uses steel or non-metallic cables or rods to provide additional load-carrying capabilities. It may or may not be fastened to a chord member. Strengthening the lower chord is generally expensive and must be done carefully to avoid causing the collapse of the structure.

Upper Chord

This normally compressive member tends to buckle. Upper chords are usually conservatively designed. Strengthening the upper chord can be accomplished by augmentation. Complete replacement is expensive and would require that the structure be temporarily supported.

Stringers

These are longitudinal members, connected to transverse floor beams. They carry the deck and live loads to the floor beams. These members can be replaced with new members or they can be strengthened with augmentation. It is relatively inexpensive to replace the stringers compared to the major truss elements.

These are usually larger transverse members connecting to the main trusses at the panel points. At these panel points, the deck and live loading are transferred to the truss. These members can be replaced or they can be strengthened by adding cover plates.

Web Members (Diagonals, Verticals and Bracing)

The diagonals are generally tension members and the verticals can be tension or compression members. The rehabilitation of these members would be similar to the bottom chord and top chord, respectively.
Appendix D

Alternate Design Standards – Sources and Examples

Sources

1. Guidelines for Geometric Design Policy of Very Low-Volume Local Roads (ADT # 400)

2. Adopted by AASHTO in 2001, these guidelines apply to the many two-lane highways in the U.S. that have very low traffic volume. Of two-lane highways in the U.S., approximately 80 percent have an average daily traffic (ADT) volume of less than 400 vehicles per day. This study demonstrates that minimum roadway widths for such highways can be used to economically and safely address operational needs. The recommended standards for low-volume highways are expected to produce meaningful savings in construction costs.

3. Policy on the Geometric Design of Highways and Streets (Green Book)

4. A Policy on the Geometric Design of Highways and Streets (known as the Green Book), published by the American Association of State Highway and Transportation Officials (AASHTO), contains the basic geometric design criteria that establish the physical features of a roadway. State standards for roadway and bridge design are typically based on the Green Book. As noted in Flexibility in Highway Design, discussed below, a project that is sensitive to an historic bridge may be achieved within the parameters established by the Green Book.

5. FHWA's Flexibility in Highway Design (on-line at www.fhwa.dot.gov/environment/flex/) offers highway engineers and project managers guidance about the flexibility available to them when designing roads and illustrates successful approaches used in other highway projects. Starting with the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, Congress made a commitment to preserving and protecting the environmental and cultural values affected by transportation facilities. This guide is intended to provoke innovative thinking for fully considering the scenic, historic, aesthetic, and other cultural values, along with the safety and mobility...
needs, in developing highway projects. It does not establish any new or different geometric design standards or criteria for highways and streets in scenic, historic, or otherwise environmentally or culturally sensitive areas, nor does it imply that safety and mobility are less important design considerations.

Flexibility in Highway Design is correlated to a large extent to the Green Book because that is the primary geometric design tool used by the highway design community. Projects highlighted in this guide were achieved working within the parameters of the Green Book to obtain safety and mobility and to preserve environmental and cultural resources. These projects used the alternatives that are available within the criteria of the Green Book. Flexibility in Highway Design encourages highway designers to expand their consideration in applying the Green Book criteria by showing possible approaches that fully consider aesthetic, historic, and scenic values, along with safety and mobility.

Options available to state and local highway agency officials to aid in achieving a balanced road design and to resolve design issues include:

- Use the flexibility within the standards adopted for each state.
- Recognize that design exceptions may be appropriate where environmental consequences are great.
- Be prepared to reevaluate decisions made in the planning phase.
- Consider developing alternative standards for different types of local roadways.
- Recognize the safety and operational impact of various design features and modifications.